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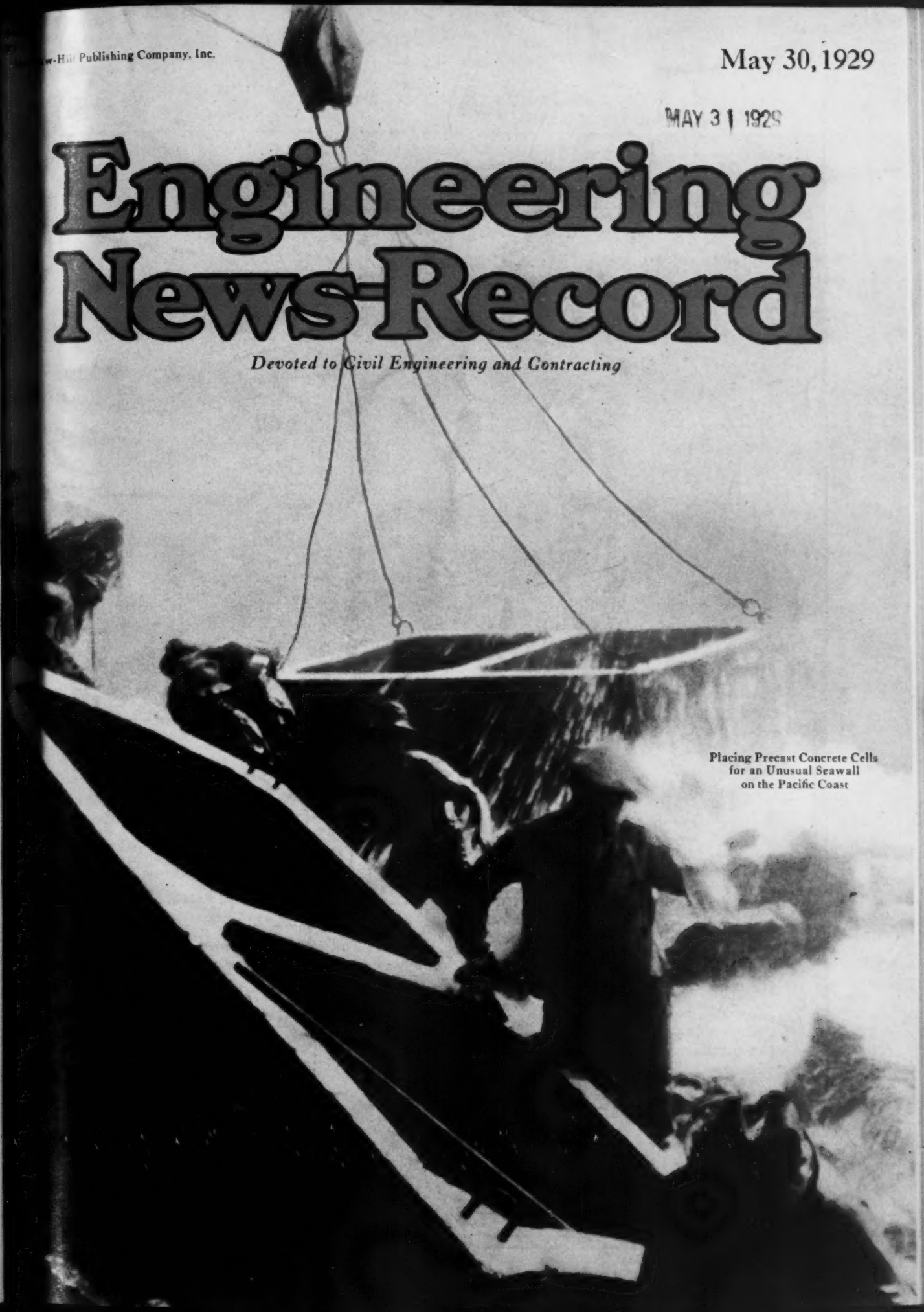

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Volume 102 NEW YORK, MAY 30, 1929 Number 22

Encouraging Support

THERE is strong encouragement in the announcements of gifts to research and library service made at the meeting of Engineering Foundation last week. The great project for research in the field of iron alloys and the Engineering Societies Library each received $50,000, and it is clear that both undertakings will gain thereby so greatly as to make it certain that they will return the sums in multiplied degree to the engineering profession and the world at large. Research and technical library facilities alike are vitally essential agencies of engineering development. May there be continued support to research, in order that all elements of engineering shall be animated by the spirit of persistent inquiry. And may the profession's central libraries, which alone can marshal the accumulated fund of technical knowledge, be strengthened still more, until their resources are available the country over.

No Precipitate Action

POSTPONEMENT of award of contracts for the Missouri floodway by the Secretary of War raises some hope that this part of the Mississippi work will not be hurried to premature construction. This hope is strengthened by the President's decision to examine the legal status of the case—to determine whether the work was fixed beyond change by legislation of the last Congress. As we stated last week, the Missouri floodway is one of the main fighting-points of the enterprise. To begin it now, before its wisdom has been adequately studied, will mean the beginning of hostilities and discussions in the Valley which would be sure to bring ultimate misfortune to the whole Mississippi project. Accordingly, the time to consider its soundness is before work is begun, and the consideration should be thorough rather than restricted by narrow legal interpretations.

A Grouting Advance

GROUT injection as a means of solidifying fissured rock and porous soils has a reputable history of half a century in engineering construction. In America its use has been as extensive as anywhere, yet the account in this issue of the extensive high-pressure grouting in the Shannon mine tells of a new and most remarkable achievement. Usually grout injection in this country has been accomplished by intermittent action and with the comparatively low pressures possible with compressed-air injectors. In fact the practice was not greatly different abroad until the Frenchman Albert Francois in 1911 made the revolutionary change of substituting continuous high-pressure (2,000 to 3,000-lb.) injection by powerful pumps and developed the idea of forcing into the finer fissures of the rock, ahead of the grout, chemicals which would meet to form a fine colloidal filling. Then grouting in Europe and particularly in England developed rapidly into one of the most certain methods of sinking water-bearing shafts that has ever been employed. It is interesting to note that the first major operation in America by this process was as difficult as any ever undertaken even with extensive European experience to draw upon.

Ten Miles a Day

CELEBRATION of the sixtieth anniversary of "last spike" ceremonies on the first transcontinental railroad, held by the Southern Pacific Company on May 10, serves as a reminder of the changes that have occurred in railroad construction in the past 60 years. There are still great areas of the West yet to be developed by settlers and served by railroads, but the hardships of wilderness pioneering and the physical prowess which featured the record of railroad construction sixty years ago are no longer important factors. Contests in the field have been supplanted by those before commissions and pens have become mightier than spike mauls in determining what line shall get its rails into a coveted town. When the last spike was driven on the first transcontinental line in 1869 there were less than 700 miles in the Central Pacific System. The system of which it now forms a part has expanded to 16,520 miles and is still expanding. The tracklaying feats of those earlier days will never be repeated, however. No longer will, and no longer can, four men swing rails into place all day long as was done when the Central Pacific's picked gang set up their unbeaten record of ten miles of track laid in twelve hours.

Unfinished Business

AN ANOMALOUS situation exists with regard to the practice of flame cutting as used in structural steel fabrication. In spite of the constantly increasing use of the process critics appear from time to time to denounce it, almost without reservation, as detrimental to the steel and unsafe for use in engineering structures. Such charges require substantiation, which to date has been entirely lacking. Tests and experiences are mentioned which are said to indicate that flame cutting should be avoided but none of these has been published for the benefit of everyone interested. To say that the data favorable to flame cutting are tainted because they come from sources interested in the sale of cutting gases is weak argument. If there are dangers inherent in flame cutting they should be shown more positively. The method has become standard in every structural shop for many uses, including the shaping of wind connection details for tall building frames. All tests so far made public show that the cutting torch compares excellently with the shear, the hack saw and the friction saw in relation to the mechanical properties of the steel, including ductility; indeed in some tests recently reported flame cutting actually raised the yield point without changing any of the other properties. Any important

engineering process deserves and must have the entire confidence of the profession. Therefore airing of all data available on flame cutting of structural steel represents one of the most important pieces of unfinished business in the structural engineering field.

A Warning

DANGEROUS conclusions may be and so frequently are drawn from isolated experiences in the quick curing of concrete that the small paving operation at Reading, Pa., described in this issue merits a word of warning as well as one of appreciation. To assume from the experience on this operation that over two days' curing is in any respect an extravagant precaution would be dangerous. Under favorable conditions and with close control many concretes have shown noteworthy strengths in 48 hours but this is a far cry from the conclusion that similar results can be expected in the general run of concreting operations. The Reading work is an interesting accomplishment in concrete paving but not a criterion of safe practice.

Terminology

CONFUSION of terms is responsible for the misdirection of much of the contractor's publicity propaganda against construction by hired labor. In a recent statement the example is quoted of a city in which two-thirds of the building permits in a certain period specify "day-labor" construction and only one-third indicate contract construction. Upon this the contractor is urged to rise in his might and smite the foe. It may be quite reasonable that he should do so, but he should be sure of the foe he is smiting. Day labor construction in the case cited and in building permit parlance generally means nothing more than construction by separate contracts. Now while this policy is in the eyes of the general contractor quite as black a beast as is hired-labor or day-labor construction properly speaking, it is not the same beast. Let us be sure of our terms before we become hectic over the infection of building construction with the virus of hired-labor practice. Separate contracts instead of general contracts are being written for a very considerable amount of building construction, but an exceedingly small volume is day-labor work in the sense that the term is used in public works construction.

The Foreign Influence

CONTEMPLATION of the engineering works of different countries and nations reveals many major differences which persist over long periods of time. They appear too regularly to be attributed to momentary conditions or to the particular genius of one man or of a small group of men. Rather, they represent the special genius of the race. Each race or country displays exceptional excellence in some field of engineering activity, and if the source of this outstanding performance could be identified and studied by the engineers of other countries it would constitute a distinct gain in the world's total of progress. Study of the works of other nations, and international exchange of information and opinion, therefore have large promise of value. They are involved in difficulties, however, that are not easily surmounted. Attempts to bring about such exchange of data and opinion by international congresses have consistently proved ineffective, and until radical improvement is made in the preparation and conduct of these gatherings they offer little hope. Individual study of practice and achievement abroad is still the most effective means of developing the desired mutual stimulation among the engineers of the world. For the present its value is limited, because engineers as a class are not much internationally minded. Progress is being made in this direction, however, and in the course of another generation it is likely to be a recognizable factor in engineering advance.

A Survival of Waterway Propaganda

THE Illinois waterway projected 20 years ago and slowly under construction for eight years has reached the stage of exhausted funds and the necessity of raising an estimated $5,000,000 more if the work is to be completed. A news item in this issue outlines the facts. Two weeks ago one of the five great lock and dam structures of the waterway was described. One lock under construction and one not begun remain to be built. Altogether they indicate where the $20,000,000 which was lightly voted a score of years ago from reflex emotion has gone, and also why $5,000,000 more is needed. Incidentally they present a notable record of engineering boldness and skill in lock design which has been made quietly by a few engineers, almost unnoticed by the great body of their profession.

Considering the situation outlined the question arises: What justification existed for this undertaking when the original $20,000,000 was provided, and what justification is there for sinking five additional millions in the project? The answer is tied up in an unusual chapter of waterways history in America.

Twenty years ago the advocates of a waterway from Chicago to the Gulf of Mexico were an aggressive body. Opposition and denial of support by the federal government had irritated them to a frenzy of activity and determination. The Illinois waterway was a gesture of independence and rebellion—Illinois at least would construct her part of the fourteen-foot channel from Lakes to Gulf! Again the army engineers blocked the path. Then came the war, and in the world turmoil the 14-ft. channel, always a project of cultivated interest, almost passed from the memory of people. But there remained $20,000,000 to spend, and some very earnest advocates for its expenditure. Now it is spent. The waterway no longer 14 ft. but only 9 ft. deep, is at most only four-fifths done.

It was not the call of commerce that impelled the legislation in 1908 for the Illinois waterway. As projected, 14 ft. deep, it had been reported upon as commercially unsound by virtually every review body outside its own propagandists. Even as later curtailed to a 9-ft. channel the opinions adverse to its transportation value were as many as those favoring it. It was the Chicago-to-the-sea waterway bloc and its claque that created the project of twenty years past and that revitalized it a decade later. Of doubtful commercial justification in 1908, the undertaking was unwarranted in a still greater measure in 1919. What is its justification for continuation? Merely that a profitable barge traffic may be hoped for, that considerable power development is possible if nearly as much more is invested in power plants as has been put into the slackwater dams, and that $20,000,000 in fine engineering structures will otherwise be lost.

To the practical onlooker the final reason appears the most compelling one. If it did not exist, scant justification for the completed waterway could be conjured out of the other two reasons. But for completion Illinois must provide some five million plus additional dollars or must induce the federal government to adopt its em-

barrassing waterway offspring and develop it to a useful existence. In case of either event the question still remains whether strangulation long ago would not have been a preferable recourse. As in its Hennepin canal, Illinois has a useless heirloom in its waterway to the Mississippi.

Interstate Water Pollution by Garbage

AMONG the many questions left for adjudication by the United States Supreme Court is that of water pollution and shore littering resulting from the dumping of garbage and miscellaneous city refuse in interstate waters. New Jersey has just received permission from the Court to sue the State of New York on this ground. A delicate question is brought forward, one whose settlement will set a far-reaching precedent.

Federal control over water pollution by either sewage or garbage is not in question. The controversy concerns the respective equities of two states which should live amicably as neighbors, and the Supreme Court is the appointed tribunal for such disputes. If no prior decision on the point has been rendered, it is probably due to the fact that disposal of garbage by dumping in water has been used but little. The only notable recent instances of water disposal of garbage and refuse which we recall are the use of the Mississippi River for a time by St. Louis; of the Pacific Ocean by Oakland; and of the Atlantic Ocean by New York City.

Ocean dumping by New York City has given rise to increasing complaints by New Jersey seaside resorts and their patrons, ever since it was resumed (so far as garbage is concerned) ten years ago after a score of years of garbage disposal by the reduction process. Repeated official protests from New Jersey to New York have been of no avail.

The fact that New York City, after practicing garbage reduction through a long period, finally shut down a new reduction plant and reverted to sea-dumping of its garbage and refuse will hardly count in its favor before the United States Supreme Court. In its favor will be an official investigation and report which led to the adoption of an incineration program that has been partly carried out. Before the long, slow process of a suit in the Supreme Court comes to a decision, the incinerator program may have been completed. Counting also in New York's favor is the study of what becomes of the New York wastes dumped at sea, made a few years ago by Arthur S. Tuttle as chief engineer of the Board of Estimate and Apportionment. However much or little weight the court may give to the conclusions from this ocean and harbor survey, New Jersey has little but gossip to controvert them. It may bring thousands of persons to swear that its coastal waters and beach were strewn with garbage, tin cans and innumerable other varieties of refuse, but it can offer little scientific evidence as to the origin of the material.

If New Jersey can make out a case that will convince the United States Supreme Court of damage to its citizens, its property owners and its thousands of visitors from other states—the latter adding to the interstate interest involved—then we may have a ruling on interstate rights and equities which will be of nation-wide value. If, as in the Supreme Court decision in the case brought by St. Louis to enjoin the use of the Chicago Drainage Canal on the ground that the water supply of the former city was menaced, a Scotch verdict of not proven is rendered, there will be little benefit to anyone.

Railway Development

ACCELERATION is an increasingly prominent characteristic in modern railway development as in other lines of progress. Not only do changes and improvements take place ever more rapidly, but those which now occur in three or five years may be more important or significant or spectacular than those made in ten or twenty years of an earlier period in railway history. Reviews of railway development are apt to cover the earliest to the latest periods and draw comparisons correspondingly. Thus they are likely to compare the days of 30-lb. rails and 130-lb. rails, of 50-ton and 300-ton locomotives, and of crude or simple operating methods and the highly perfected and complicated methods of today. Comparisons of this sort are useful and interesting as indicative of the total range of progress, but tell little of our present rate of movement.

A far more instructive and practical form of review is that of comparing what is still considered modern practice with the most highly advanced practice. Such a review is given in another column by Charles A. Morse, veteran railroad engineer and ex-chief engineer of two of the large western trunk railroad systems in succession. In general, he covers the twenty-year period of 1907 to 1927, but he records also special features of development within the latter part of this period. Attention may be called to the substance of this review by quoting one significant statement: "In all the life of our railroads there have never been such great improvements as during the past seven years."

Naturally the subject is treated as a matter of economics and transportation rather than of technical engineering, since, however important the engineering works and structures or however large and novel the locomotives, they are not designed to illustrate engineering developments but to serve as means of forming or improving lines of railroad transportation. They are simply the scientific means to a commercial end.

Remarkable changes and improvements in the construction, equipment and operation of railroads have been seen in the period of twenty years, and especially within the past decade. Such periods are within the experience of numerous engineers in railway service, yet probably few of them have visualized or realized the developments taking place continually before their eyes. And only a much smaller proportion is represented by those who attempt to foresee developments of the next five, ten or twenty years. Yet this is what must be done by the men who are to do the work of the coming generation.

To many a young engineer the heavy rails, substantial bridges, elaborate signal installations, powerful equipment, ponderous and fast trains, extensive yard and terminal facilities and highly organized operating methods are commonplace conditions. If he should consider the question of railway development, he is likely to compare these present conditions with those of, say, the period after the Civil War. But if he would turn his thoughts back simply to the modern period of the present century, and particularly the last decade, he would find much to surprise him and perhaps lead him to wonder what further changes are now developing or are in prospect for the near future. Such a study would help him also to realize very definitely the relation which the science of engineering bears to the practical and economic problems involved in advancing the business of railroad transportation.

Aerial-Tramway Development for Construction Haulage

Engineering Improvement Opens Heavy-Haulage Field to Aerial Tramway — Coolidge and Pardee Dam Construction Illustrates Possibilities and Economies in Materials Transportation

By M. P. Morrison
Tramway Engineer, American Steel & Wire Company, Worcester, Mass.

Aerial Tramways demonstrated their effectiveness as transportation systems originally in mining. In their early use it was tacitly understood that their field was confined to the transportation of comparatively small tonnages over ground that was so rugged as to make a surface railway impracticable because of the steep grades or prohibitive in cost because of the bridging or tunnelling involved. A tramway carrying 50 tons an hour was considered a heavy-duty installation. Also it was mechanically a comparatively crude installation.

Despite its crudity and small capacity the aerial tramway performed a remarkable service to transportation in inaccessible mining districts. Now, through continual improvement it has become a very capable heavy-tonnage transportation tool. Today there are tramways carrying 300 tons an hour.

With the growth in capacity there has come a more perfect knowledge of tramway engineering and a great improvement in the design and manufacture of the cables employed as tracks.

Power-operated bin gates and the automatic spacing, dispatching and attaching of the carriers has reduced the labor of attendance. Trolley and bucket design has advanced, and in other details and in operating functions there has been great improvement.

It is this progress that has made the aerial tramway a formidable possibility in construction haulage, as illustrated by the two dam construction tramways described here—Coolidge Dam *(Engineering News-Record,* Sept. 20, 1928, p. 438) and Pardee Dam *(Engineering News-Record,* Feb. 14, 1929, p. 259). In the article which described the Pardee Dam there was an excellent appraisal of the tramway performance. Here the description is centered on the mechanics and the structures of the tramways. —Editor.

THE AERIAL TRAMWAY owes its place as a means of transportation to the following advantages not found in other transportation systems:

(1) It is independent of the contour of the ground so that structures, streams and mountains are spanned without bridges or tunnels. The length of unsupported span is limited only by the depth of intervening valley required to give clearance for cable deflection or, on level ground, by the height of the cable supporting towers. It is independent of weather conditions.

(2) Right-of-way difficulties are much fewer than with other systems since the towers supporting the tramway cables are few and can be placed on boundary lines.

(3) The tramway is built to suit the transportation requirements (from a few tons per hour up to several hundred tons per hour) so that the investment is somewhat in proportion to the capacity required.

(4) The cost of operation is virtually independent of the length and decreases rapidly with an increase in the hourly tonnage capacity.

(5) There should be no rehandling of material, since the system is so flexible as to permit delivery or distribution to any location, regardless of differences in elevation and of steepness of grade.

Types of Aerial Tramways

Tramways can be divided broadly into two general classes: (1) single rope or mono-cable, and (2) double rope or bi-cable.

The mono-cable is a distinctly European system of tramways, rather limited to English tramway builders. It consists principally of an endless moving steel rope to which are attached the tramway carriers; the attachment of the carriers to the rope being in some cases permanent clips and in others detachable saddles. This system has never found favor with American tramway builders because of the rapid wear of the ropes, the uncertainty of the carriers negotiating steep grades especially under unfavorable weather conditions, the limitation in the length of permissible cable spans, etc.

The bi-cable system is used almost exclusively in the United States, Canada and Mexico and consists of two stationary cables stretched parallel to each other in a horizontal plane and from 8 to 10 ft. apart. These track cables perform exactly the same function as the rails in a surface railway; the one on which the loaded carriers travel is larger than the other on which the empty carriers return. In addition to the track cables there is the traction rope, and endless moving rope furnishing propulsion to the carriers by means of detachable grips that clamp the rope. The carriers are pendent from trolleys running on the track cables.

Continuous and Reversible Types

Both of the systems described are known as continuous tramways since the motion of the endless traction rope is continuously in one direction. The loaded carriers attach and detach from this moving traction rope automatically at the loading or unloading terminals of the tramway without interruption to the motion of the traction rope, there being a constant flow at regular intervals of loaded carriers going one way on one cable and empty carriers returning on the other cable, the transition being made at both ends by means of a rail loop.

In addition to continuous tramways there is also the reversible tramway consisting of a track cable and an endless moving traction rope with one carrier permanently clipped to it. The traction rope is operated by a reversible motor which pulls the carriers back and forth on its track cable between the loading and discharge terminals. This is called a single reversible tramway and is used for relatively small capacities and over short distances, seldom exceeding 2,000 ft. By using two track cables and operating the carrier on each cable alternately in opposite directions, a so-called double-reversible

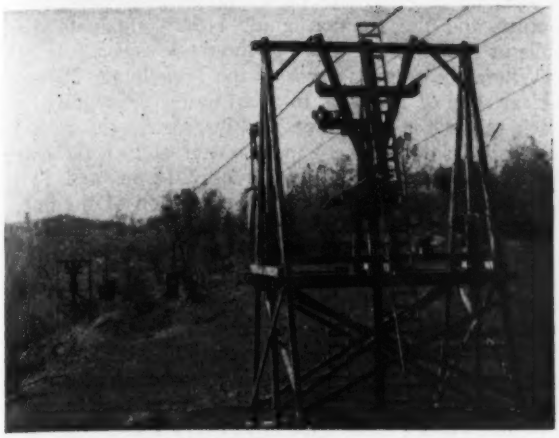


FIG. 1—TYPICAL LINE CONSTRUCTION ON PARDEE DAM TRAMWAY

tramway results with double the capacity of a single reversible over the same distance.

Limitations and Possibilities

Aerial tramways up to 300 tons per hour capacity and up to 13 miles in length have been built successfully, but these by no means denote the allowable limit for either length or capacity.

An aerial tramway can be built with two or three pairs of track cables and traction ropes thus doubling or tripling its capacity. The capacity can be increased also by increasing the size of the individual carriers and by using heavier track cables. As an example there is a recent installation of a single reversible tramway carrying a 27-ton load on four 2-in. track cables over a clear span of 2,600 ft. at a speed of 1,800 ft. per minute.

The length limitation is determined solely by the size of traction rope which must be strong enough to overcome the tension imposed by the friction of the entire system and the difference in elevation between the lowest and highest point of the tramway through which the weight of the carriers is raised or lowered.

If W is the gross weight of a carrier in pounds; S, the interval between carriers in feet; R, the weight of the traction rope per foot; H, the difference in elevation between two points at a distance L, and F, the friction factor, then the tension in the traction rope at the height point will be:

$$\frac{WH}{S} \pm \frac{WLF}{S}$$

This is assuming the weight of the carriers as a load uniformly distributed over the length of the traction rope, the plus sign being used if the carriers are pulled up grade and the minus sign if they are moving down grade.

The friction factor is very small since the carrier trolleys are equipped with ball or roller bearings, but it is evident that the tension in the traction rope and consequently its size increase rapidly with the weight of the individual carrier, close spacing and the increase in the difference in elevation.

These considerations show that the length of the traction rope is decidedly limited under adverse conditions, but that does not limit the length of the tramway, since all that is necessary is to have several loops of traction rope each having its own drive. It is only necessary to provide a control station for two adjourning loops of traction rope, in which the carriers, automatically detach from one loop and attach to the next. The track cables are continuous and offer no interruption to the passage of the carriers. Any number of such control stations can be built so that there is no physical reason that would limit the aerial tramway to any particular length. A tramway 54 miles in length is in operation in Colombia, South America, and projects are under way for much longer tramways in that country.

The applicability of an aerial tramway to the solution of a given transportation problem must be investigated as a comparison between it and other methods of transportation. Since the design of a tramway is made to fit the given transportation problem, it is extremely difficult to establish any general rules relative to cost of installation, operation and maintenance. In general:

1. The initial cost depends upon length, hourly tonnage capacity, unit weight of material to be transported, the profile of the ground, the size of storage bins if any, at the terminals and the material used in the construction of the tramway structures and foundations.

2. The cost of operation depends on the number of control stations if any, on the hourly tonnage somewhat and on the requirements for distributing the material at the discharge terminal.

3. The cost of maintenance depends on the number of carriers on the line and consequently its length and likewise on the footage of track cables and traction rope.

Pardee Dam Tramway

The new $7,000,000 Pardee Dam for the water supply of the coast cities bordering San Francisco Bay requires about 615,000 cu.yd. of concrete. All the aggregates for this concrete are transported about 3½ miles to the dam site by aerial tramway. This tramway merits attention because of its rather unusual combination of length, heavy duty, a long river span and a number of improvements not found in older types.

The special design and equipment features were developed broadly to meet four requirements: (1) A long line, (2) a duty of 220 tons an hour continuously 24 hours a day, (3) a route with a considerable amount of adverse grades and one horizontal angle, and (4) a structure and construction investment predicated on temporary use.

Line Location and Structures—The profile of the tramway drawn to exaggerated scale is shown in Fig. 2. It

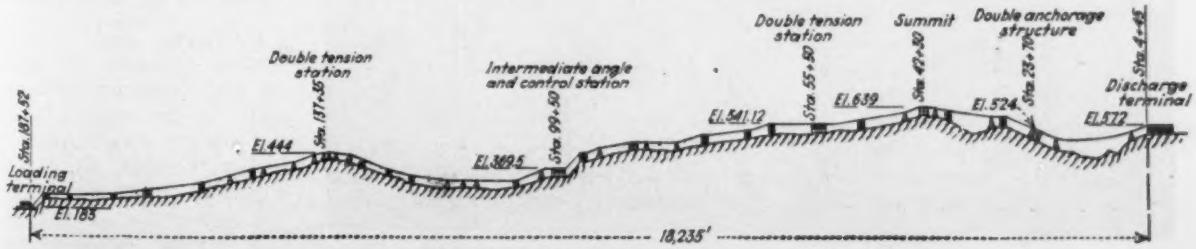


FIG. 2—PROFILE OF 3½-MILE AERIAL TRAMWAY AT PARDEE DAM

FIG. 3—TRACTION ROPE DRIVING MECHANISM AT ANGLE STATION

traverses a rough, rolling country having some fairly sharp grades, and just before the dam site is reached it spans the rather imposing canyon of the Mokelumne River. With various rises and dips the line mounts to the summit 456 ft. above the loading terminal and then drops to the discharge terminal 389 ft. above the loading terminal. The preponderance of grade adverse to the load is to be noted. The route selected also made necessary a horizontal angle of about 5 deg. at about mid-length of the line.

Because of the combination of considerable adverse grade and a large hourly tonnage to be transported it was necessary to build the tramway in two sections so as to limit the tension on the traction rope. The logical arrangement was to combine the angle and driving station. This was done, and the driving mechanism of the first section was placed at the angle station. This mechanism consists of a 125-hp. motor operating the driving sheave by a silent chain drive as shown by Fig. 3. A duplicate driving plant for the second section was located at the discharge terminal at the dam site. The several stations are described more in detail in a succeeding section. They are all of timber construction.

The regular line structure is indicated by Fig. 2. All towers are of timber because of the temporary nature of the installation. Attention is called to the long rocking saddles supporting the track cables, and the traction rope guide rollers which are so located as to keep the traction rope parallel to the track cable at all times. The rocking saddles of large radius minimize bending stresses and flexure and the traction guide rollers eliminate down pulls or flexure destructive to the track cables.

Where the tramway crosses the Mokelumne River on a clear span of 1,320 ft., to avoid undue deflection of the track cables the cable size was increased—the cable on the loaded side being $1\frac{3}{4}$ in. diameter and on the empty side $1\frac{1}{8}$ in. diameter, although only $1\frac{5}{8}$ in. and $1\frac{1}{8}$ in. diameter respectively on the other portion of the line.

Track Cables and Carriers—One of the primary considerations of the designers was to insure long life of track cables, not only because of the cost of replacing worn cables but principally because of the necessity of eliminating delays or interruptions.

The cables are divided into sections about 4,500 ft. long, each section of cable being anchored at one end and counterweighted at the other, thus maintaining a constant, known cable tension in every span. All cables

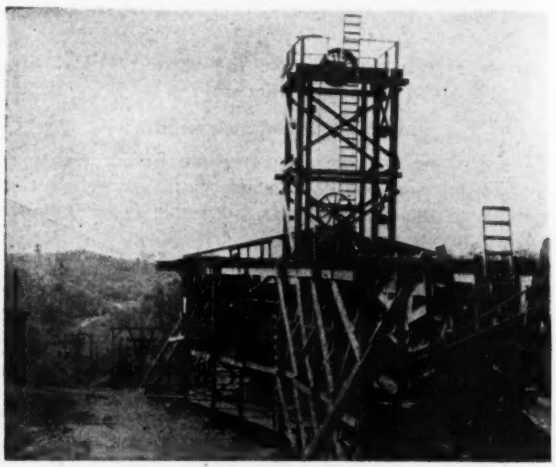


FIG. 5—ANGLE CONTROL STATION ON PARDEE DAM TRAMWAY

are of the locked-coil type, which gives a perfectly smooth cylindrical track for the carriage wheels, thus reducing abrasion to a minimum on both cable and wheels.

The tramway buckets are carried by articulated, four-wheel carriages, so designed as to distribute the load uniformly over the four wheels and thus insure minimum bending or flexure of the track cables. The buckets are of 32 cu.ft. capacity and carry $1\frac{1}{2}$ tons each. The speed of the traction rope is 470 ft. per minute and the buckets are spaced 192 ft. apart, with a time interval of $24\frac{1}{2}$ seconds. The traction rope is $\frac{7}{8}$-in. crucible steel.

Operating and Control Stations—Besides the loading and discharging stations there is the midline angle and control station and the tension stations, all having important functions in the line operation.

A typical double-tension

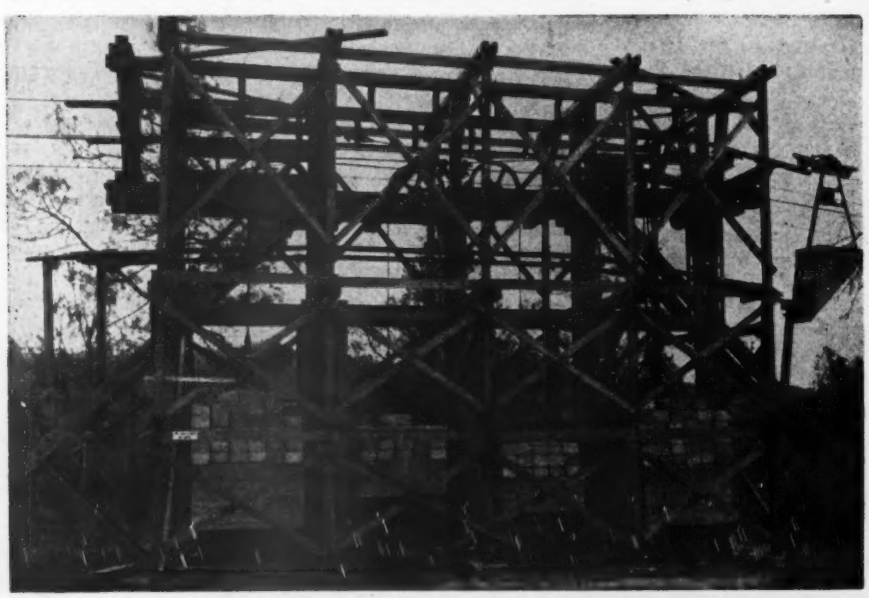


FIG. 4—DOUBLE-TENSION STATION ON PARDEE DAM TRAMWAY

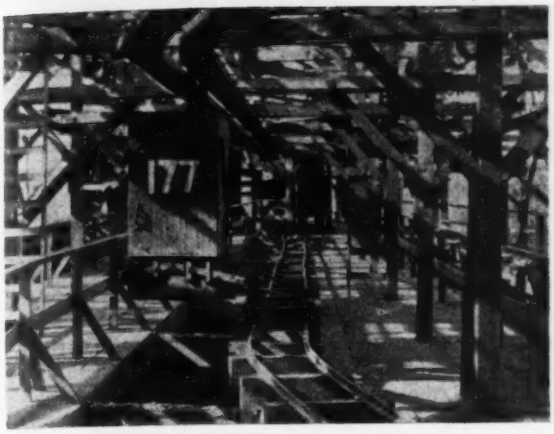


FIG. 6—AUTOMATIC DISCHARGING STATION PARDEE DAM TRAMWAY

station is shown in Fig. 4. It will be noted that the lower portion of the concrete cable counterweight is a solid block against which the track cables are originally pulled. The remaining counterweight necessary is secured by adding loose concrete blocks of known weight. The counterweight clears the wood blocking underneath by only a few feet, so that if for any reason the carriages are removed or lifted from the cable spans, the counterweight immediately comes to rest on these blocks, thus preventing the empty cables from rising to a new or higher position which for various reasons is objectionable.

The method of transferring the carriage wheels from the track cables onto the track rails of the stations is clearly shown at the right of the view; this transition is accomplished by long articulated inverted U-shaped hoods connecting the track rail to the track cable. The track cable is of course deflected sideways and downward to anchorage to afford free passage to the carriers.

Fig. 5 shows the central angle and control station which divides the tramway into two sections. This station has an arrangement whereby the tramway bucket carriers on entering are detached from the traction rope which pulls them over the first section of the tramway, and after running over a rail through the station by gravity under their own momentum again enter an automatic attacher and go out on the second section of the tramway automatically without manual control or operation.

Prominent in this view is the wood tower supporting the floating tension frame and counterweight of the traction rope of the first section. It is by means of this device, equipped with a suitable counterweight, that the proper tension in the traction rope is maintained and any variations of line pull are absorbed.

Fig. 6 shows the interior of the discharge terminal which is built on top of the storage bins of the mixing plant at the dam site. A tramway bucket is shown in the foreground.

The design of this terminal is somewhat novel and several features are noted. The buckets, which are of the end-dump gated-hopper type, are guided through the entire length of the station by means of parallel overhead guides. Three longitudinal bins or compartments are served by three independent lines of overhead tramway track rails which are given a grade so that the buckets after automatically detaching from the traction rope continue with uniform speed and dump their load while in motion, at any desired point. Sand and two sizes of stone are delivered to the three compartments from which these materials are fed to the concrete mixers placed directly below the bin.

The discharge terminal is in telephone communication with the loading terminal and the crushing plant and the operator of this station calls for whatever material happens to be needed at any particular time. He is notified by the loading terminal operator when sand or either grade of stone is beginning to come over and sets his tripping carriage described below over any of the compartments in which it is desired to dump this material.

The dumping is accomplished by a movable tripper carriage shown in Fig. 6. Being movable and mounted on light rails and consisting of a sloping tripping plate it can be quickly swung out of the way if tripping over one or the other compartment is desired. Each of the three compartments is provided with one of these tripping carriages which can be moved along the parallel tracks next to each compartment quickly and easily.

After the load is dumped, the buckets continue on their way to the outgoing traction rope while still retaining sufficient momentum to send them through the automatic attacher. As all action is automatic, the only labor necessary is of a supervisory character. Not more than two men need be employed at the discharge terminal when delivering 220 tons per hour.

At the loading terminal there are six chutes in the bin spaced 8 ft. apart for loading tramway buckets. The overhead tramway rail in front of these loading chutes is slightly sloped downward toward the automatic spacer and dispatcher. After each bucket is filled, a slight push by the operator sends it on its way to the automatic spacer where two or more buckets are constantly held in reserve. The spacer and automatic dispatcher are connected to the traction rope by means of a timing gear which by operation of electrical equipment, energizes this dispatcher regularly when the traction rope has traveled 192 ft., thus dispatching or releasing a bucket to the haul rope at this exact regular interval.

The loading terminal bin is divided into three compartments of which one carries sand, one small size stone, and the other large size stone. The loading terminal and discharge terminal are connected by telephone and the operators at the loading terminal and at the crushing plant are notified some time ahead as to what material is required at the mixing plant and they accordingly send out either sand or fine stone or large size stone as may be required. The operation of loading the tramway

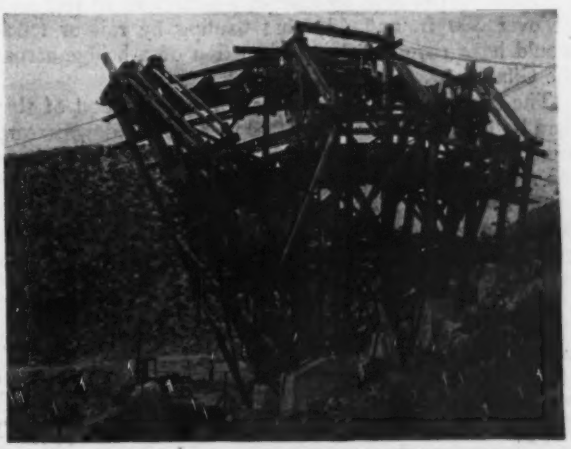


FIG. 7—BREAK-OVER STRUCTURE ON COOLIDGE DAM TRAMWAY

FIG. 8—RIVER SPAN AND GRAVEL PLANT AT COOLIDGE DAM

buckets by means of undercut type circular bin gates is an extremely simple one and requires only four or five seconds so that while carriers are spaced 24½ seconds apart there is ample time in between the carriers. From the above it will be seen that the hourly tonnage capacity of this tramway could be increased by the addition of carriers with a closer spacing.

From the dispatcher the buckets travel by gravity on the overhead tramway track rail to the attacher; the rails are of such slope that as the bucket reaches the attacher it has a speed about equal to that of the traction rope. The bucket or carriage operates through this automatic device smoothly without supervision or attendance.

Coolidge Dam Tramway

Another example of the successful application of an aerial tramway to the construction of a large dam is that of the Coolidge Dam, located about nine miles from San Carlos, Arizona, on the Gila River. The considerations that led to the adoption of this method of transportation were (1) that while the air-line distance from the dam-site to the gravel beds was only about 2,000 ft. a road about 1½ miles in length would be required with a grade of about 10 per cent because of a difference in elevation of over 300 ft. and (2) that hauling by rail or truck would have required the construction of a bridge across the Gila River.

The sand and stone used for the construction of this dam lie in large eddy beds 2,000 to 5,000 ft. downstream from the dam. The sand and gravel were excavated from the river bed and delivered to the screening and crushing plant by means of power shovels and cars and from there conveyed and stored in a 5,000-ton storage pile over a belt conveyor tunnel. The belt conveyor delivered the stored sand and stone, separated into four sizes, to four compartments of the loading bunkers of the aerial tramway, from which the material was loaded into the tramway buckets.

The tramway was about 1,900 ft. long and was equipped with track cables of the locked-coil type. In all 27 buckets of 20-cu.ft. capacity of the revolving type were operated on this tramway. The buckets were spaced 200 ft. apart and traveled at the rate of 500 ft. per minute, arriving at the damsite at intervals of 24 seconds. One of these buckets is shown approaching the break-over station in Fig. 7. Because of the temporary nature of this installation, all structures were of timber. From the loading terminal the tramway rose over 300 ft. to a summit, at which point the break-over structure was located and the track cables made a vertical angle of about 30 deg.

One of the important features of this structure was the battery of traction rope guide rollers by means of which the traction rope was kept parallel with the track cables. The transition from the cables to the tramway track rail was accomplished by means of long inverted articulated U-shaped hoods, and the track cables were carried on suitable rail chairs located directly under the track rail.

From the profile Fig. 9 it will be seen that there were only two spans between the loading and discharge terminals. Fig. 8 shows the tramway span between the loading terminal and the break-over structure at the summit, this being clear span of 1,323 ft.

An examination of Fig. 7 showing the break-over structure and Fig. 9 showing the river span reveals that the track cable conveying the empty buckets was at a higher elevation than the track cable conveying the loaded buckets. These two cables were located in this manner so that the empty buckets could swing over the loaded ones without interference, which arrangement was necessary on account of the prevalence of high velocity winds in the canyon of the Gila River.

It is interesting to note that while the original installation included hand-operated loading gates for loading the tramway buckets, the contractors later installed hydraulic jacks to operate these gates.

In recent installations where compressed air is available all bin gates are usually equipped with air cylinders so as to avoid all manual labor in the loading of buckets, thus still further reducing the operating labor. Where compressed air is not available steam can be used or the bin gates can be operated by a small electric motor. The loading of the tramway buckets constitutes the only hard labor attached to the operation of the tramway.

To convey the material from the loading terminal to the discharge terminal over a distance of about 1,900 ft. with a rise of 305 ft. and at the rate of 150 tons per hour requires olny 50 hp., which is supplied by a motor.

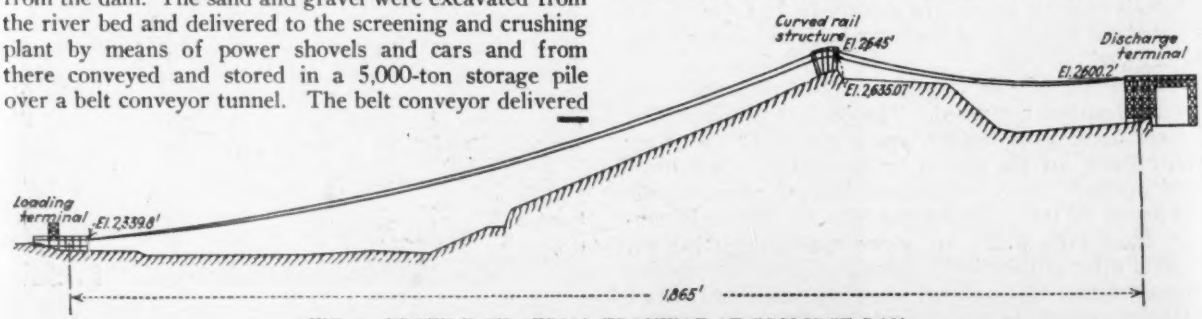


FIG. 9—PROFILE OF AERIAL TRAMWAY AT COOLIDGE DAM

Suspension Bridge of 170-Ft. Span Meets Water-Main Emergency

Trestle Supporting 36-In. Pipe Line Conveying San Francisco Water Supply Is Replaced as Cut Causes Landslide

By T. W. Espy

Assistant Chief Engineer, Spring Valley Water Company, San Francisco, Calif.

SUPPORT of a 36-in. steel pipe line which conveys a large part of the San Francisco water supply was recently transferred from a timber trestle to a 170-ft. suspension bridge when a highway cut caused renewed subsidence in an old landslide. The bridge was constructed to meet this emergency and was completed, to the point of taking the load, in seventeen days, during which time the field work was usually well in advance of the office design.

A heavy side-hill cut on a state highway relocation project approximately 6 miles south of San Francisco was required where the water main parallels the highway about 300 ft. up the slope. A landslide had occurred at this point years before, requiring about 140 ft. of pipe to be carried on trestle bents over the subsidence. In an effort to prevent the cut from causing further movement of the slide the highway department started the construction of a masonry retaining wall to hold the ground between the highway and the pipe line. However, warned by a slight sag in the trestle, the Spring Valley Water Company decided to carry the pipe over the slide on a suspension bridge, believing that consolidation of the retaining wall backfill would cause serious subsidence before the load could be taken by the wall.

Excavation for a road to the bridge site was started, but the timbers and supplies had been dragged up the slope by hoist and the bridge completed before the road was ready for use. Concrete for the foundations was brought in buggies from a small concrete plant which was in operation on the pipe line about 600 ft. away.

WATER MAIN CARRIED ON SUSPENSION BRIDGE
Note the subsidence of the trestle which formerly supported the pipe.

The two anchors for the main cables were made by pouring concrete into pits at either end of the bridge. Each pit was excavated to give a volume of 25 cu.yd. of concrete. Two concrete piers were also poured to support each tower. The towers supporting the cables are 32 ft. high and 170 ft. apart with corner posts of 14x14-in. timbers and a cap of cast iron to carry the cable across the top of each tower.

The main supporting cables are 2 in. in diameter and about 370 ft. long from anchor to anchor. Placed over the towers, the cables were tightened by blocks and a winch to provide a minimum length of hanger at the center.

The floor of the suspension bridge consists of the two stringers and cross-bracing which were supporting the pipe on the trestle. These stringers had been built up of three 8x8-in. timbers bolted together to form a continuous 8x24-in. girder, apparently to allow for unequal settlement of the bents without damage to the pipe line. The rigidity offered by these girders was utilized to prevent swaying of the bridge by the wind and to provide for possible sag of individual hangers.

Hangers, spaced at 14-ft. intervals, consist of $\frac{7}{8}$-in. cable clipped at the lower end to threaded rods 4 ft. long. These rods pass through holes drilled in the ends of 10x10-in. timber crossbeams and were equipped with plates, washers and nuts for taking up the load.

One of the smaller problems which caused considerable study was to provide a simple

HIGHWAY CUT STARTS MOVEMENT OF OLD SLIDE
Suspension bridge supports pipe line before masonry retaining wall stops renewed subsidence.

means for fastening the hangers to the supporting cables. The difficulty was solved by providing an ordinary 2-in. cable clip with a small casting which allowed the clip to be tightened on the cable and still leave an eye large enough for the hanger cable and thimble.

When the bridge was ready to take the load, the amount of additional sag expected at the center was estimated and the proportional sag calculated for the other hangers. The load was transferred by screwing up each pair of hangers in successive short rises based on the expected sag at each point. The emergency nature of the work had not allowed time for accurate office design of details, and as a result the length of the first set of hangers had to be corrected. Full load caused a sag of 3 ft. at the center of the cables.

Loading was accomplished without interruption of the water service. After the situation had been relieved, time permitted more exact design and the hangers were adjusted slightly to agree with accurately calculated lengths. These lengths provide an even grade for the pipe and at the same time a correct distribution of load along the cable.

As had been expected, the subsidence continued and thirteen days after shifting the load the old supports had settled as much as 10 ft., as shown in the accompanying illustration.

The work was done by the construction forces of the Spring Valley Water Company under the personal supervision of the writer.

Notes on German Sewage-Works

INFORMATION regarding a number of interesting features of sewage-works in Germany, drawn from the German Year Book for Sanitary Chemists and Engineers (Von Wasser) for 1928, appears in *Public Health Abstracts* for April 6, 1929. The notes were extracted by Dr. Willem Rudolfs, director of sewage research, Agricultural Experiment Station, New Brunswick, N. J. Their substance is as follows:

Fish Pond Sewage Disposal—Fish ponds for sewage disposal are used in a number of cities and villages in South Germany. At Zerzabelshof the sewage is pretreated in a "Dywidag" system, consisting of a sedimentation basin connected with a digestion tank, the settled sewage flowing through the digestion compartment. Many troubles were encountered. The effluent goes to a fish pond of about two acres, which takes care of the settled sewage of 1,500 people. Purification in the fish pond is about 50 per cent. Conclusions: (1) Sufficient dilution water must be present, especially during dry-weather flow; (2) the dilution water should be rich in calcium; acid water is detrimental.

Gas Production From Sewage Sludge—The composition of the gases produced at Stuttgart, Halle and Munich is:

	Methane	CO_2	H_2	N_2
Stuttgart	73.5	14	4.8	4.7
Halle	70–76	23–29	...	0.5
Munich	77.5	17.8	...	4.6

The gas in Stuttgart is sold for 7 pfg. per cubic meter and at Halle for 4 pfg. In Nurnberg the gas production in 1925 was 90 cu.ft. per capita per year; in 1926, 115; in 1927, 142.

Regulation of Sludge Digestion With Lime—Laboratory experiments with control of the hydrogen-ion concentration, during digestion, confirm the findings in this country (United States) and are considered as important. Fresh solids produced without lime 120 liters gas in 130 days and with lime 200 liters in 80 days. Reaction control should be practiced in all disposal plants and is especially adapted in separate sludge digestion plants.

Sugar Beet Waste Disposal—The waste is settled and digested in a series of lagoons and the effluent run over filter beds. Most of the work is accomplished in three small lagoons and the effluent diluted 1: 10 with river water does not have a further oxygen demand. Large quantities of fungus growth are present (*Sphaerot ilus*).

Refuse Disposal in Borough of Brooklyn, New York City

Company Has Five-Year Contract for Final Disposal of Garbage, Ashes and Rubbish

By Erle L. Collins

Chief Engineer, Brooklyn Ash Removal Company, Inc., Brooklyn, N. Y.

THREE incinerating plants for garbage and rubbish, each of 500 tons capacity, are being built in the Borough of Brooklyn, New York City, by the Brooklyn Ash Removal Company, Inc. The work is being done as a part of the conditions of a five-year contract entered into on April 1, 1928, between the company and the city of New York through the Department of Street Cleaning for the final disposal of all of the garbage, ashes and rubbish in the borough. The population served is about 2,500,000 and the quantity of material to be disposed of under the contract will exceed an average of 6,000,000 cu.yd. per year, of which about half will be rubbish, a third ashes and a sixth, or 1,000,000 cu.yd., garbage. The contract price is 58c. per cubic yard, not including collection, which is done by city employees in city-owned equipment. The company has disposed of the same classes of material produced in the Borough of Brooklyn for twenty years past under similar contracts running from one to five years.

CONTRACT PRICES FOR THREE INCINERATING PLANTS, BOROUGH OF BROOKLYN, NEW YORK CITY

		Contractors*
South Brooklyn:		
Cost of site	$335,000	
Excavation and dredging	39,750	Clemente Contracting Co., Inc.
Building	465,000	Tilt-Hargan Co.
Chimneys	31,000	M. W. Kellogg Company
Equipment	380,000	Hiler Engineering & Construction Co.
Total	$1,250,750	
Greenpoint:		
Cost of site	$121,500	
Excavation and dredging	79,500	Clemente Contracting Co., Inc.
Building	514,398	United Fireproofing Co.
Chimneys	32,800	M. W. Kellogg Co.
Equipment	380,000	Hiler Engineering & Construction Co.
Total	$1,128,198	
Paerdegat Basin:		
Cost of site	$59,624	
Excavation and building	359,500	George Colon Construction Co. Inc.
Chimneys	32,000	M. W. Kellogg Co.
Equipment	364,000	Hiler Engineering & Construction Co.
	$815,124	

*All of New York City. The Clemente Company is in Bronx Borough, and all the others in Manhattan Borough except the Hiler Company, which is in Brooklyn Borough.

Under the terms of the new contract the contractor is to provide, operate and maintain at his own cost and expense, not less than seventeen dumps or disposal plants, including garbage and rubbish incinerators. In addition, the contractor is to operate two city-owned incinerators, as stated in more detail below. The plants already operated by the company are six waterfront and eight railway stations for the receipt of ashes and garbage, one station for rubbish only and the two city-owned incinerators. At the fourteen waterfront and railway stations receiving both ashes and garbage the two classes of material are separately handled.

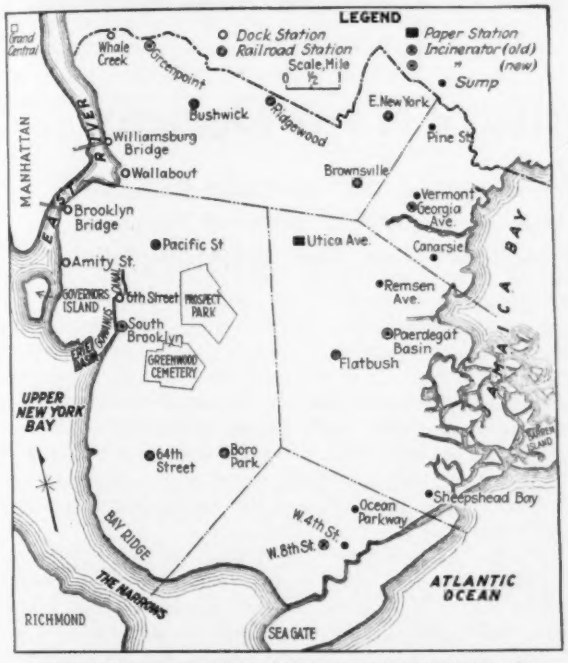
Ashes at the waterfront stations are dumped directly onto scows, from which, after transportation, they are later unloaded by electrically driven cranes and used for land fill; at the railway stations the ashes are loaded into specially designed 100-cu.yd. railway cars and taken to land fills.

Rubbish at all fifteen stations is received and sorted on conveyor belts. The unsalable material is burned in

incinerators and the residue is loaded onto the scows or the cars already mentioned and taken to land fills.

The city furnishes the contractor with two garbage and rubbish incinerating plants, each of 100 tons capacity in 24 hours, which the contractor is to maintain and operate during the full term of the contract so that their use may be continuous and uninterrupted. At the expiration of the term of this contract the contractor is obligated to turn back these plants to the city in as good physical condition as they were when he started their operation, ordinary wear and tear excepted.

In addition, the contractor, at his own cost and expense, is required to provide, maintain and operate three garbage and rubbish-incinerating plants, including the land, buildings, structures, furnaces, flues, chimneys, machinery, appurtenances and appliances necessary for complete installation in the three sections of Brooklyn known as South Brooklyn, Greenpoint and Paerdegat



BROOKLYN BOROUGH REFUSE COLLECTION AND DISPOSAL DISTRICTS AND STATIONS

Basin. These plants are to be of the type and design of the garbage- and rubbish-incinerating plants now being operated under the supervision of the Department of Street Cleaning in the boroughs of Manhattan and Brooklyn. Each of the new plants is to have a capacity of receiving within an eight-hour period, and of destroying within a 24-hour period, up to a maximum of 500 tons of garbage and rubbish mixed, the mixtures to be destroyed being of variable proportions by weight up to a maximum of 75 per cent garbage and 25 per cent rubbish, with provision for such ashes as may be brought in incidental to the garbage or rubbish collection.

The contractor secured competitive bids for the construction of these plants under separate contracts for: (1) excavation and dredging, (2) buildings, (3) furnaces and equipment, (4) chimneys. Regular advertisement was made for the proposals for a period of ten days. The bids were opened in public at the office and in the presence of the commissioner of street cleaning. Awards were made, with the approval of the commissioner of street cleaning, to the lowest responsible bidder. Provision is made in the contract for the capture of these three incinerating plants by the city at the expiration of the contract by the payment by the city to the contractor of 75 per cent of the cost price, as approved by the commissioner at the time of award of the several construction contracts, plus the cost of the several sites which were approved by him as they were purchased by the company.

During the development of the plans and specifications for these three new plants it seemed advisable to provide for the reception of ashes at two of them located along the waterfront. Additional facilities were also included at all three plants for the reception of large quantities of rubbish by providing two large rubbish-salvaging units at each plant, each unit capable of receiving and handling 1,500 cu.yd. of rubbish in eight hours.

In compliance with the requirements of the contract, as outlined above, three sites have been purchased and the contracts for all three plants have been awarded as shown by the accompanying table.

The guarantees upon which the acceptance of the furnaces and auxiliary equipment is based are those usually required as follows:

The contractor shall guarantee that the plant, when installed complete in accordance with the final approved plans and specifications . . . will meet the following guarantees and official tests to be made to demonstrate the ability of the equipment to meet these guarantees, . . . when the furnaces are burning, without additional fuel at or about their rated capacities, . . . and as herein specified:

1. That at no time during the normal operation of each furnace will the temperature in the combustion chamber, as ascertained by continuous record, during the time of the tests fall below 1,250 deg. F. for more than three minutes in any hour, and that an average temperature of at least 1,450 deg. F. will be maintained.

2. That the residue from the furnaces will be thoroughly burned to a clean dry ash practically free from combustible organic matter other than carbon.

3. That the combined capacity of furnaces of each plant will not be less than 500 tons (of 2,000 lb.) in 24 hours.

4. That there will be no smoke emitted from the chimney of a degree of darkness or density greater than that determined by Chart No. 1, Ringleman's Smoke Scale, as supplied by the U. S. Geological Survey.

5. That there will be no dust emitted from the top of the chimney.

6. That there will be no odor emitted from the plant.

7. That there will be no disorderly scattering of garbage and rubbish outside of the intended areas or receptacles in or about the plant which is offensive to the average eye during the normal operation of the plant.

8. That the man-hours of labor and the kilowatt-hours of power per ton of refuse incinerated will not be greater than that given in the statement submitted with the contractor's bid. The kilowatt-hour guarantee shall exclude pumping and ventilation and salvage equipment.

9. That all material and workmanship furnished under this contract shall be of the best quality in every particular and that the contractor will remedy all defects which develop due to imperfect material or improper workmanship during the first six months of actual service, free of expense to the company.

The equipment contractor guaranteed (as demanded under paragraph 8 above) that the power consumed in the operation of the plant, exclusive of that for pumping, ventilation and rubbish salvaging units, would not be greater than 4.86 kw.-hr. per ton.

The contractor further guaranteed that the man-hours of labor required for the operation of the plant, exclusive of rubbish-salvaging labor, would not be greater than 1.1 per ton, when operating at capacity.

A full description of the plants and the equipment used, together with an outline of the new developments embodied in the design of these plants, will be given in an article to be published in a later issue. —EDITOR.

NEW DOUBLE TRACK ON KANSAS DIVISION, 1927, C. R. I. & P. RY.

Railroad Improvements of Two Decades

Large Operating Economies Effected in the Period 1907 to 1927 by Grade Reduction, Realignment, Double-Tracking, Signals and Heavier Engines in Spite of Decreased Rates—Results on the Rock Island Are Typical of What May be Accomplished

By Charles A. Morse
Consulting Engineer, Chicago
(Chief Engineer of the Rock Island System, 1913-1929)

FEW people other than officials of our railroads realize the great changes that have been made in the physical characteristics of the railroads within the past twenty years. Comparing 1907 and 1927, we see marked increases in size and weight of locomotives and cars, with such increased axle loads as to necessitate strengthening the track, roadbed and structures. Grades and curves have been reduced, much second track laid, yards rebuilt, signal systems installed and engine terminal facilities improved, all involving heavy initial expense, but in general with the net economic result of expediting the movement of trains and reducing the cost of railway operation. In the following review of conditions the statements are based largely on the records of the Atchison, Topeka & Sante Fe Railway, the Chicago, Burlington & Quincy Railroad and the Chicago, Rock Island & Pacific Railway, these three being fairly representative of the railroad systems west of Chicago. Some features of their equipment and operating conditions are summarized in Table I.

Transportation and Rates

Prior to 1887, the great problem in this country was to secure adequate transportation facilities. The building of a railroad into a new area permitted its settlement and development due to the cheap and expeditious movement as compared with horse or mule transport. But after the district had become settled there came a reaction, and people began to call for cheaper transportation in an effort to compete with other districts that perhaps were nearer to markets. Then the railroads were subjected to criticism because they could not transport freight from new and distant sections as cheaply as from older sections nearer to their markets. Eventually this condition led to the Federal and State regulation of rates which began about 1907. The first effort in regulation was along the lines of a reduction in both freight and passenger rates, which, with a small business panic in 1907, put the railroads up against a hard proposition.

From 1907 until the World War, or late in 1914, the railroads wrestled with adverse conditions and tried in every way to reduce the cost of operation. But as they were not showing good earnings it was hard to get credit and to borrow money needed for improvements which would reduce this cost. In spite of this handicap, railroads which could borrow money did much to help the situation, but others went steadily backward until many were forced into receivership and had to reorganize in an effort to reduce overhead expenses.

Economics of Heavier Power

An improvement that required the least amount of money was the purchase of heavier locomotives, and this was done very generally. But it required the strengthening of track, roadbed and bridges, the use of larger turntables, the extension of roundhouse stalls and the lengthening of pits in repair shops, all of which involved additional expenditures. Railroads with sufficient credit and foresight began the revision of alignment and grade, as this resulted in the same economy as an increase in size of power, while it permitted a further reduction in operating expenses at a later time by then installing the heavier power.

The poorer railroads were obliged to resort to an immediate purchase of heavier power, as that expense could be handled on the installment plan. They could turn the locomotives on wye tracks, let them project out-

side the roundhouse, and repair them out of doors. They could also put falsework under light bridges and thus manage to get along for the time being. But it was expensive work, and they did not secure the economy they would have secured if they could have done the improvement work required to handle the heavy power. The old saying that "The poor man's ways are poor ways always" was well illustrated on a large portion of the railroads in the trying days from 1907 to 1915.

The use of heavier motive power and larger and heavier rolling stock has proved so satisfactory as a means of reducing cost of operation, that its increase is likely to continue, although there is a general feeling that a limit will be reached in the economy thus obtained. With further increase in this direction coming more gradually, the railroads within the next five or ten years will be relieved of much of the heavy outlay for equipment. The resulting decrease in operating expenses should then permit them to earn a fair return on their investment and at the same time to make a reduction in transportation rates. They would have been in a position to begin reducing freight rates by this time, had it not been for the heavy decrease in passenger earnings, due to the development of gasoline-operated highway vehicles. This decrease has largely offset the increased earnings resulting from the use of heavier power and rolling stock.

Locomotive Equipment

The increase in weight and tractive power of locomotives between 1907 and 1927 has been over 50 per cent (see Table I) and the engines have undergone great changes. Today they use superheated steam, are fired with automatic stokers, and are equipped with boosters to assist in starting the train and to give additional power over short stretches of heavy grade. Coal is prepared by being run through crushers before it is loaded on the tender. The boiler water is treated to reduce the incrusting solids, and this treatment is carried to a greater refinement than was the practice 15 or 20 years ago.

TABLE I—RAILWAY CONDITIONS: 1907 AND 1927

	A., T. & S. F. Ry.		C., B. & Q. Ry.		C., R. I. & P. Ry.	
	1907	1927	1907	1927	1907	1927
Miles operated	9,353	12,113	8,663	9,013	7,522	8,081
Increase in mileage	.....	29.5%	.....	4.0%	.....	7.4%
No. of locomotives	1,676	2,090	1,604	1,794	1,343	1,538
Average tractive power of locos. (A)	29,225	48,075	24,426	39,163	24,616	38,434
Average weight, without tender, tons	81.74	130.47	No record		69.79	107.11
Average weight on drivers, tons	62.66	99.17	No record		55.42	84.89
Passenger train cars	1,135	1,483	1,209	1,340	801	1,098
Freight train cars	49,770	83,090	51,662	65,596	37,862	46,211
Work train and company cars	221	5,465	6,866	4,500	2,706	2,167
Revenue passengers; thousands (B)	10,525	5,363	13,052	6,229	10,987	5,279
Passengers carried 1 mile; thousands (B)	969,651	1,340,720	892,269	811,008	725,234	646,091
Revenue tons; millions	16	47	25	42	17	34
Gross revenue ton-miles; millions	6,842	16,248	7,169	11,942	4,281	8,589
Increase in gross revenue ton-miles (C)	.....	97%	.....	64%	.....	93%

(A) The high average tractive power for the Santa Fe Railway is due to its requirements for powerful engines in mountain territory.
(B) Passenger figures do not include suburban passengers with commutation tickets.
(C) Increase corrected for change in mileage from 1907 to 1927.

Improvement in the locomotives has required improvement in shop machinery and tools, with many new developments such as the use of electric and oxy-acetylene cutting and welding devices. The modern boiler-washing plant, automatic cinder-handling plant, and the modern coaling station have enabled the turning, cleaning and running-repair work to be done in much less time, thus increasing the hours of service on the road.

It is interesting to note that within the past five to seven years the railroads have been able to handle a much increased tonnage of business with a decreased number of locomotives. As illustrating this feature, the figures in Table II show plainly the results secured by the use of larger locomotives and their more intensive use.

Physical Improvements

Where a railroad was able to secure money for improvements in grade and alignment, the returns have been good, the result being such net earnings as are shown by the Santa Fe Railroad. That railroad, under the able direction of the late President Ripley, began as early as 1900 to reduce grades and improve alignment. Much of this work was in connection with the construction of second track and this policy has been continued up to the present time. No better example of the operating economies of such improvements can be found. Similar practice must and will be followed during the next ten to twenty years, and will result in a decided reduction in transportation costs.

TABLE II—TRAFFIC AND LOCOMOTIVES

Railways	Billion Gross Ton-Miles 1922	1927	No. of Locomotives 1922	1927
A., T. & S. F. Ry	11.17	16.25	2,159	2,090
C., B. & Q. Ry	11.75	11.94	1,929	1,794
C., R. I. & P. Ry	6.65	8.59	1,605	1,538

Beginning about 1916, the war in Europe so stimulated business in this country that men were scarce. In 1917, wages began to increase. So many men then went into the army that few were available for railroad improvement work until about 1920, and it took the most of both that year and 1921 to overcome the lack of upkeep on the roads during the war.

About 1922, however, a decided improvement was begun on the physical condition of the railroads and this has continued up to the present date. In all the life of our railroads there have never been such great improvements as during the past seven years. The high cost of labor has stimulated the introduction of mechanical means, with results that are highly satisfactory, and this development bids fair to continue.

Railroads that were constructed originally to develop new territory were built as cheaply as possible. As the country became settled and cities sprang into existence, resulting in increased business, it became necessary, or at least desirable, to improve the railroads, especially as to alignment and grades. But under the new regulatory bodies, created primarily to force reductions in rates, the net earnings of the railroads rapidly decreased, and a loss of credit naturally followed, continuing from about 1907 to 1916. As a result, in the country west of Chicago only a comparatively small amount of work has been done in the way of improving grades and alignment. But much more of such improvement must and will be done in the next few years.

Track and Structures—In the meantime, it has been necessary to strengthen and improve the track on the original location in order to permit the use of heavier loads and higher speeds. Today, we look especially at the speed, and we compare the operation of two railroads by the tons moved per freight-train-hour. This change has meant the use of heavier rails and more ties,

as well as a continually increasing depth of ballast below the bottom of the tie in order to increase the bearing on the roadbed. This last in turn has required the widening of embankments and cuts, with consequent lengthening of culverts and drains.

Again, bridges that were strong enough for the light power and rolling stock, have had to be replaced with stronger structures, while it has been necessary to widen through bridges, to accommodate the larger equipment. For a long while a 7-ft. side clearance, or 14 ft. between trusses or girders, was sufficient, but some years ago we had to widen this to 8 ft. and 16 ft. respectively. Then with increased weight and speed it developed that the foundations were not strong enough, so that bridges of all classes have had to be rebuilt, even when no change was made in alignment or grade. Bridges in 1907 were

TABLE III—INCREASE IN HEAVY RAILS

Railways	Per Cent of Rails Heavier than 70-Lb. 1907	1917	1927	Mileage in 1927 Track	110-Lb. Rail	100-Lb. Rail	90-Lb. Rail
A., T. & S. F. Ry.*	37	67	86	12,113	1,606	....	6,352
C., B. & Q. Ry.	..	67	75	9,013	92	795	4,309
C., R. I. & P. Ry.	43	54	65	8,081	36	1,139	1,693
Average	40	63	75	....	....	....	....

*The A., T. & S. F. Ry. has also a 5-mile test section of track laid with 130-lb. rails.

designed for Cooper's E-55 loading, while in 1927 the E-65 loading was being used. All this work has been a great drain on earnings, as it called for continual expenditure either to pay interest on the money borrowed for additions and betterments, or to pay for the portion of the cost that was chargeable to operation.

Track construction has shared in the general improvements, as increased speed and weight of power developed weak points unknown on the earlier railroads. When creeping of rails first developed, the original fish-plate was changed to an angle bar, so that spikes driven in the slotted flange tended to prevent creeping. As this was not sufficient with faster and heavier trains, the anti-creeper or rail anchor was devised and is now as important a rail fixture as the joint itself. To prevent the rail from cutting the tie the metal tie-plate was introduced. At first these were only about $4\frac{1}{2}$x$6\frac{1}{2}$ in. and $\frac{1}{16}$ in. thick, but they are now sometimes $7\frac{1}{2}$ in. wide, 10 to 12 in. long and $\frac{1}{2}$ to $\frac{3}{4}$ in. thick.

For ties, it was often necessary to use soft woods, especially in the south and west, and even where oak could be secured it would decay in eight to ten years. Cost of renewal was heavy, especially when the first cost rose from 35 to 60c. Preservative treatment to prevent this rapid decay and increase the life has developed until now a large proportion of the ties are treated. Today the cost of a tie in the track, including its insertion, is from $1.50 to $2. With 3,200 ties per mile this runs into a heavy investment, but on the other hand the annual renewals are decreased materially.

Ballast and Rail Conditions—A record of ballast conditions on the Rock Island fairly reflects the average changes on other railroads west of Chicago. In 1907, with 7,522 miles operated, 4,243 miles were ballasted. In 1917 the figures were 7,971 and 5,547 miles respectively, while in 1927 they were 8,081 and 6,143 miles. This includes stone, shale, burned clay, gravel and cinders, the remainder having only the sand or earth of the roadbed, as on light branch lines or portions of main line in sandy country. But the mileage does not tell the whole story. In the days of light rails and light rolling stock, the average depth of ballast was 6 to 10 in. under the ties. In 1917 it had increased to 8 to 15 in., while by the end of 1927 the average depth was 15 to 24 in. Previous to the valuation date (1915) the Rock Island had standard depths of 12-in. and 15-in. under 90- and 100-lb. rails, respectively. Since then there has been no standard, but on the heavy-traffic lines there is much track with 18 to 24 in. of ballast under the ties.

In 1907, the Santa Fe had five miles of 90-lb. rail and its next heaviest was 85-lb., while 85-lb. was the heaviest on both the Burlington and the Rock Island. In 1927, these three roads were laying 110-lb. rail on their heavy-traffic lines, representing an increase of 30 per cent in weight of their heaviest rails. These developments are summarized in Table III, but there is still a problem in securing uniform quality of steel in heavy rails.

Maintenance-of-Way—The cost of maintenance-of-way has undergone a wonderful change during the past 15 years. It started with substitution of power-operated section cars for the old time hand-cars. The introduction of open-hearth steel rails and heat-treated track bolts and splices has greatly decreased the cost. Then came the increase in wages due to the World War. In 1913, trackmen averaged $13\frac{1}{2}$c. per hour, west of Chicago, and they worked ten hours per day. Now they average 35c. per hour and eight hours per day. With such a combination of increased wages and decreased hours of work there has been a steady increase in the introduction of labor-saving machinery. This has resulted in a decrease of about one-third in the number of men required on track work, but an increased output of those retained. Maintenance-of-way is now handled much more efficiently than ever before, and the cost per mile has not increased as much as has the revenue per mile of the railroads.

Road Crossings and Protection—The advent of the power-operated highway vehicle not only took away a large part of the passenger business and much of the short-haul freight business of the railroads, but the ordinary planked road crossings were not smooth enough for power vehicles at 30 to 50 m.p.h. and the railroads had to improve many of these grade crossings. With

TABLE IV—MULTIPLE TRACKS AND SIGNALS

	A., T. & S. F. Ry. 1st Main Track Miles	A., T. & S. F. Ry. 2d, 3d, 4th Tracks Miles	C., B. & Q. Ry. 1st Main Track Miles	C., B. & Q. Ry. 2d, 3d, 4th Tracks Miles	C., R. I. & P. Ry. 1st Main Track Miles	C., R. I. & P. Ry. 2d, 3d, 4th Tracks Miles
1907	9,353	363	8,663	592	7,522	289
1912	10,733	827	8,808	727	7,712	471
1917	11,291	1,008	9,018	1,005	7,972	449
1922	11,710	1,291	9,040	1,049	8,008	472
1927	12,113	1,779	9,013	1,120	8,081	552
1927 p. ct. increase	29.5	14.7	4.0	12.4	7.4	6.8

	A., T. & S. F. Ry. Automatic Block Signal	A., T. & S. F. Ry. Automatic Train Control	C., B. & Q. Ry. Automatic Block Signal	C., B. & Q. Ry. Automatic Train Control	C., R. I. & P. Ry. Automatic Block Signal	C., R. I. & P. Ry. Automatic Train Control
1907–1908	123	....	....	....	161	....
1912	209	....	98	....	969	....
1917	656	....	708	....	973	....
1922	1,236	....	1,299	....	973	22
1927	2,809	176	2,110	162	974	337

increasing speed and volume of road traffic came the necessity for more crossing signs and then crossing signals, and finally the demand for separation of grades. At first all of the expense for grade separation was assessed against the railways, but it is now admitted that their share should be 25 per cent of the cost in many cases, and not over 40 per cent in any case. When we consider the number of grade crossings per 100 miles of railroad, it is evident that they add heavily to the maintenance cost of the railroads.

Second Track and Signals—The demand for more rapid movement of revenue freight has resulted not only in better track and equipment and improvement in alignment and grade, but has also required the construction of second track where the volume of traffic would warrant it. In 1927, the three trunk lines mentioned, with 29,207 miles of main track, had 3,451 miles of second, third and fourth tracks, or 11.3 per cent of main track mileage. The individual figures are give in Table IV.

With increased speed and number of trains on certain parts of a railroad it became necessary to provide for safety in operation. The block system was introduced, both to safeguard and expedite train movements. At first there were manual block signals; then came automatic electric block signaling, and later the automatic train-control. Another development has been the installation of remote-control switches and a system of central-control dispatching, whereby the train dispatcher handles not only the signals but also the switches. This last movement to promote rapid handling of trains over an engine district has only come into prominence within the past five or six years, but the next decade is likely to see a great advance in perfecting and applying the system.

BUILDING NEW EMBANKMENT AND CONCRETING FOR HIGHWAY UNDERPASS SIMULTANEOUSLY

Improvements and Operating Economies

A Rock Island Example—A good example of what can be done in the way of expediting freight train movements, is an improvement program completed in the fall of 1927 on 82 miles of the Chicago, Rock Island & Pacific Railway between Topeka and Herington, Kan., the latter being a division point where business from California and western points joins with business coming north from Oklahoma and Texas. This stretch of 82 miles, together with 67 miles from Topeka to Armourdale (Kansas City, Kan.), is operated as one engine district of 149 miles. It handles a heavy freight business, and in addition has 16 passenger trains daily (eight each way), with seven passenger trains between 8 a.m. and 6 p.m.

Prior to 1924, this 149-mile stretch had to be operated as two engine districts, as trains could not get over it in 16 hours. It had double track from Armourdale to Topeka, beyond which it was a single-track line, with a ruling grade of 0.8 per cent. In 1917, the traffic between Topeka and McFarland, 32 miles west, where the Colorado business comes in, was such that freight trains average but 7.5 m.p.h., as compared with 16.2 m.p.h. between Topeka and Armourdale, over the double-track Union Pacific line, which was also handling its own but lighter business, amounting to about 50 per cent of that of the Rock Island.

Double Track and Grade Revision—In 1918, a second track was constructed for five miles west of Topeka and five miles east from McFarland. With this ten miles of double track in the 32 miles from Topeka to McFarland, freight trains were averaging 11 m.p.h. as compared with former 7.5 m.p.h. When the entire 32-mile stretch was double-tracked, in 1923, freight trains averaged 20 m.p.h. During the same year, there was a change of line and second track built from Herington east to Latimer, the next station, giving a ruling grade of 0.5 per cent eastbound, and 0.4 per cent westbound, with 1-deg. curves. After the completion of these two pieces of second track, trains could be operated over the entire 149 miles between Armourdale and Herington within the 16-hour day. As the majority of the trains made the trip in not more than 12½ hours, which called for no overtime penalty, the division point at Topeka was abandoned.

The balance of the line was doubled-tracked gradually, the last stretch being put into operation on Nov. 1, 1927. Grades were reduced in connection with the construction of the second track, and when it was completed, the ruling grades were 0.5 per cent eastbound and 0.4 per cent westbound, except for 7½ miles on Alta Vista hill. This it was not practical to reduce, and it remained with a ruling grade of 0.8 per cent and 3-deg. maximum curves, uncompensated. From Armourdale to Herington, the line was originally equipped with automatic signals, which were remodeled to take care of double track. Reverse or both-direction signaling was installed where the 0.8 per cent grade was left, so that passenger trains would not be delayed by freight trains dragging up this 7½ miles of heavy grade.

This second track and grade reduction was completed Nov. 1, 1927. One year later, many through freight trains were making the run from Herington east to Kansas City, Kan., in 6½ to 8 hours. From Kansas

City west to Herington, including the 7½ miles of 0.8 per cent grade, they were making the run in 7½ to 9 hours, while the average for all freight trains was 17.5 m.p.h. between Topeka and Herington, as compared with 16.2 m.p.h. between Armourdale and Topeka. This increased speed between Topeka and Herington, was due to the improvements between these points, including double outside passing tracks, interlocked at the incoming ends and having spring switches at the outgoing ends, while the double track of the Union Pacific, between Topeka and Armourdale, was equipped with middle passing tracks, without interlocking or spring switches.

Cost and Savings—The total cost of the improvement between Topeka and Herington, 82 miles of second track, with reduction of grades, an extension of Herington yard, new passing tracks averaging 12 miles apart, and about ten miles of reverse signaling, was $6,138,977, charged as follows: Additions and betterments, $5,284,287; operation, $854,690. Savings in cost of operation due to the improvement program amounted to $1,481,049 per year, making a return of 28 per cent on the addition and betterment charges, and 24.10 per cent on the total cost. Deducting 5 per cent for interest on the total cost, gives a net saving in operating costs of $1,172,545 per year.

Furthermore, these improvements changed the 82-mile line from a retarder to an accelerater of business. Thus the reduction in cost of operation is but a portion of the benefit the railroad obtains, as the shortening of time for the trip makes it possible to secure and handle satisfactorily some competitive business which otherwise could not have been secured.

Conclusions

A striking and interesting illustration of the economic results which may be obtained by a combination of building second track, reducing grades, improving alignment and passing tracks and introducing the latest development in heavier power equipment, is afforded by a recent test run made over the above-mentioned line from Herington to Kansas City. This run was made with one of the new 4:8:4 freight locomotives which the Rock Island is putting in service this year. It has a tractive effort of 66,620 lb., with a booster engine which can add 13,075 lb. tractive effort. The engine in question took a heavy freight train from Herington to Kansas City, 149 miles, in 9 hr. 44 min. or at the average speed of 22.78 m.p.h. From Herington to McFarland it hauled 5,013 tons and attained a maximum speed of 44 m.p.h. Thence to Topeka it hauled 6,016 tons and made a maximum speed of 47 m.p.h. From Topeka to Kansas City the train load was 5,985 tons. This performance may be compared with the operation in 1923, when a 2:8:2 locomotive of 57,000 lb. tractive effort hauled a train of 2,600 tons, but had a helper up the grade for the first ten miles. As a rule this older type of engine could not make the run in 16 hours, so that the 149-mile engine district had to be split at Topeka, while at that time the freight tonnage being moved over the district was only about half of what is now being moved.

GRADE REVISION IN CONNECTION WITH DOUBLE-TRACKING
Cut for new second track at the left.

Most of the large railroads have stretches of track which might be improved along the lines described, with equally good results, and the coming decade will see their attention centered on improvements of this kind, where a big decrease in operating expenses can be predicted. With money plentiful and with credit of the railroads much improved by the work they have been doing during the past six or seven years, there is no reason why such improvements should not be carried out on a large scale.

Southern Pacific Lines in Mexico Damaged by Bandits

During the year 1928 serious damage was done to the lines of the Southern Pacific Company in Mexico, according to the company's annual report. Bridges and trestles and the timber lining of tunnels were fired by bandits and Yaqui Indians. Eight trestles, having an aggregate length of 1,545 ft., and 1,723 ft. of timber lining in two tunnels were destroyed during the year by such fires. The cost of replacing these structures as well as the bridge over the Fuerte River and the damage caused by floods in the Presidio, Rosario, and Sonora Rivers amounted to $584,000.

Supreme Court Disapproves Methods Used in Determining Value of Railroads

District Court Decision in O'Fallon Railway Case Reversed Because Interstate Commerce Commission Did Not Take Present Reproduction Costs Into Consideration

METHODS used by the Interstate Commerce Commission in fixing values upon railway property used in public service were declared by the U. S. Supreme Court to be not in accord with the law of the land in a decision rendered on May 20 in the case of the St. Louis and O'Fallon Railway Company and the Manufacturers' Railway Company against the United States of America and the Interstate Commerce Commission. The decision is of great importance because upon it depends the final settlement of all the railroad valuation cases involving billions of dollars worth of property now pending before the Interstate Commerce Commission.

The Transportation Act of 1920 added two sections to the Interstate Commerce Act, one (19a) directing the Interstate Commerce Commission to determine the value of the property of each railroad of the country and the other (15a) requiring the commission to prescribe just and reasonable rates, to specify what constitutes a fair return upon the aggregate value of railroad property, and authorizing it to collect from the railroads one half of the excess income over the fair return which it specifies. The law also provided that where two or more railroads were operated as integral parts of a single system such railroads were to be considered as a unit in computing excess income.

Acting under the authority of this law the commission has determined values for the great majority of the railroads of the country and has begun proceedings to collect excess income from some. Among the latter were the St. Louis & O'Fallon Railway Company and the Manufacturers' Railway, which, because of their small size and the fact that both were owned by the same interests were highly suitable for use in a suit to test the validity of the methods used by the I. C. C. in carrying out the provisions of the Transportation Act. Consequently, as soon as the commission had issued its order directing the O'Fallon to pay over to it certain excess income suit was brought to annul the order. The order was sustained by the district court and was taken to the Supreme Court on appeal.

Case Reviewed by the Court

The Supreme Court's decision, except for paragraphs to prove that the case is properly before it, is as follows:

These are cross appeals from the final decree of the District Court, Eastern Missouri,—three judges sitting—in a suit to annul an Interstate Commerce Commission order, dated February 15, 1927, which directed St. Louis and O'Fallon Railway Company to place in a reserve fund one-half of its determined excess income for the years 1920 (ten months), 1921, 1922 and 1923 (that is half of the sum by which the net railway operating income for each of those years exceeded six per cent of the ascertained value of property devoted to public service); and to pay to the Commission the remaining one-half with six per cent interest beginning four months after termination of the year, i. e., May 1, 1921, 1922, 1923 and 1924.

Section 15a, added to the Interstate Commerce Act by Transportation Act, 1920, contains nineteen paragraphs. Of those specially important here, 1, 2, 3, 5, 7 and 8 are copied in the margin; 4 and 6 follow:—[The paragraphs which the Court quotes outline the procedure in determining the value of railroad property and the recapture of excess income—Editor.]

After an investigation instituted under Section 15a, May 14, 1924, for the purpose of determining incomes received by St. Louis and O'Fallon Railway Company (The O'Fallon) and Manufacturers' Railway Company (The Manufacturers'), asserted to be parts of one system, for the years 1920-1923, the Commission found:—(1) Although the stock of both corporations was mostly owned by the Adolph Busch Estate and their principal officers were the same, they were not carriers operated under common control and management as a single system within paragraph 6. (2) The Manufacturers' had received no excess operating income. (3) The value of The O'Fallon's property devoted to public service in 1920 (ten months) was $856,065; in 1921, $875,360; in 1922, $978,874; in 1923, $997,236; and during each of those years it received net operative income exceeding six per cent upon the stated valuation.

The above-described recapture order followed.

Wisconsin Railroad Commission v. *Chicago, Burlington & Quincy R. R. Co.*, 257 U. S. 563, and *Dayton-Goose Creek Railway.* v. *The United States*, 263 U. S. 456, point out the general purpose of the Transportation Act, 1920, and uphold the validity of Section 15a.

Roads Not Operated as Single System

The Manufacturers' is a switching road with thirty miles of track within St. Louis, Missouri. The O'Fallon—a coal-carrying road—has nine miles of main line, all in Illinois, and this connects with The Terminal Railroad at East St. Louis. Through the latter deliveries are made to sundry points in St. Louis, some of which are on The Manufacturers' line. "The distance between the railroad of the O'Fallon and the railroad of the Manufacturers' is about 12 miles, and all communication by rail between the two properties is effected over the tracks of the Terminal, including a bridge over the Mississippi River." Both the Commission and the District Court held that the record failed to show these two roads were under common control and management and operated as a single system within the meaning of paragraph 6. We accept their conclusion.

The Commission directed The O'Fallon to pay 6% interest on the recaptured one-half of its ascertained excess net railway operating income beginning four months from the end of the year during which the excess accrued (Sec. 6). The District Court rightly ruled that as the carrier made bona fide denial of any excess under circumstances sufficient to justify a contest, no interest should have been imposed for any time prior to the final order. Not until then could the carrier know what, if anything, it should pay.

Also, we think the District Court rightly rejected the claim that excess earnings were not recapturable unless and until the Commission had fixed a general level of rates intended to yield fair return upon the aggregate value of carrier property either as a whole, or in some prescribed rate or territorial group. Congress, of course, realized that final valuations would require prodigious expenditure of time and effort; but the language concerning recapture indicates that prompt action was expected. Practical application of paragraphs 5 and 6 does not necessarily depend upon prior compliance with paragraphs 2 and 3. The Act should be construed so as to carry out the legislative purpose. The proviso of paragraph 3 prescribing action to be taken during two years beginning March 1, 1920, and the clause of para-

graph 6 excepting the income of certain roads prior to September 1, 1920, are hardly compatible with this claim by the carrier.

Paragraph 4, Section 15a, directs that in determining values of railway property for purposes of recapture the Commission "shall give due consideration to all the elements of value recognized by the law of the land for rate-making purposes, and shall give to the property investment account of the carriers only that consideration which under such law it is entitled to in establishing values for rate-making purposes." This is an express command; and the carrier has clear right to demand compliance therewith. *United States ex rel. Kansas City Southern Railway Co.* v. *Interstate Commerce Commission,* 252 U. S. 178.

Elements of Value Defined

"The elements of value recognized by the law of the land for rate-making purposes" have been pointed out many times by this Court. *Smyth* v. *Ames,* 169 U. S. 466; *Wilcox* v. *Consolidated Gas Co.,* 212 U. S. 19; *Minnesota Rate Cases,* 230 U. S. 352; *Southwestern Bell Telephone Co.* v. *Public Service Commission,* 262 U. S. 276; *Bluefield Water Works & Improvement Co.* v. *Public Service Commission,* 262 U. S. 679; *McCardle* v. *Indianapolis Water Co.,* 272 U. S. 400. Among them is the present cost of construction or reproduction.

Thirty years ago, *Smyth* v. *Ames* announced (546):

> "We hold, however, that the basis of all calculations as to the reasonableness of rates to be charged by a corporation maintaining a highway under legislative sanction must be the fair value of the property being used by it for the convenience of the public. And in order to ascertain that value, the original cost of construction, the amount expended in permanent improvements, the amount and market value of its bonds and stock, the present as compared with the original cost of construction, the probable earning capacity of the property under particular rates prescribed by statute, and the sum required to meet operating expenses, are all matters for consideration, and are to be given such weight as may be just and right in each case. We do not say that there may not be other matters to be regarded in estimating the value of the property. What the company is entitled to ask is a fair return upon the value of that which it employs for the public convenience. On the other hand, what the public is entitled to demand is that no more be exacted from it for the use of a public highway than the services rendered by it are reasonably worth."

In *Southwestern Bell Telephone Co.* v. *Public Service Commission,* (287) we said: "It is impossible to ascertain what will amount to a fair return upon properties devoted to public service without giving consideration to the cost of labor, supplies, etc., at the time the investigation is made. An honest and intelligent forecast of probable future values made upon a view of all the relevant circumstances, is essential. If the highly important element of present costs is wholly disregarded such a forecast becomes impossible. Estimates for tomorrow cannot ignore prices of today."

The doctrine above stated has been consistently adhered to by this Court.

Commission's Findings Reviewed

The report of the Commission is long and argumentative. Much of it is devoted to general observations relative to the method and purpose of making valuations; many objections are urged to doctrine approved by us; and the superiority of another view is stoutly asserted. It carefully refrains from stating that any consideration whatever was given to present or reproduction costs in estimating the value of the carrier's property. Four dissenting Commissioners declare that reproduction costs were not considered; and the report itself confirms their view. Two of the majority avow a like understanding of the course pursued.

The following from the dissenting opinion of Commissioner Hall, concurred in by three others, accurately describes the action of the Commission:—

> "In order to determine the value of the O'Fallon property devoted to carrier service during the recapture periods, 10 months in the year 1920 and the years 1921, 1922, and 1923, we start with a valuation or inventory date of June 30, 1919. The units in existence on that date are known. Original cost of the entire property can not be ascertained. As to the man-made units we estimate the cost of reproducing them in their condition on that date and in so doing apply to the units installed prior to June 30, 1914, the unit prices of 1914, representing a fairly consistent price level for the preceding 5 or 10 years. To like units, installed after June 30, 1914, and prior to June 30, 1919, we apply the same prices, but add a sum representing price increases on those units during that period. For the third period, from June 30, 1919, down to each recapture date, we abandon estimate and turn to recorded net cost of additions less retirements. On this composite, made up of estimated value for two periods and ascertained net cost for the third period, the majority base a conclusion as to value at recapture date of the man-made items. Land goes in at its current value as measured by that of neighboring lands.
>
> "Without summarizing the other processes, all clearly stated in the majority report, it will be observed that the rate-making value arrived at for the successive recapture periods, as for example the year 1923, rests upon 1923 market value of lands; costs of other property installed since June 30, 1919; unit prices of 1914, enhanced by allowance for increased cost of units installed during June 30, 1914-1919; and, for the units installed prior to June 30, 1914, constituting by far the major part of the property, unit prices of 1914 without any enhancement whatever. As to this major part of the carrier's property devoted to carrier purposes in 1923 no consideration is given to costs and prices then obtaining or to increase therein since 1914."

In the exercise of its proper function this Court has declared the law of the land concerning valuations for rate-making purposes. The Commission disregarded the approved rule and has thereby failed to discharge the definite duty imposed by Congress. Unfortunately, proper heed was denied the timely admonition of the minority—"The function of this commission is not to act as an arbiter in economics, but as an agency of Congress, to apply the law of the land to facts developed of record in matters committed by Congress to our jurisdiction."

The Question of Reproduction Cost

The question on which the Commission divided is this: When seeking to ascertain the value of railroad property for recapture purposes, must it give consideration to current or reproduction, costs? The weight to be accorded thereto is not the matter before us. No doubt there are some, perhaps many, railroads the ultimate value of which should be placed far below the sum necessary for reproduction. But Congress has directed that values shall be fixed upon a consideration of present costs along with all other pertinent facts; and this mandate must be obeyed.

It was deemed unnecessary by the Court below to determine whether the Commission obeyed the statutory mandate touching valuations since the order permitted The O'Fallon to retain an income great enough to negative any suggestion of actual confiscation. With this we cannot agree. Whether the Commission acted as directed by Congress was the fundamental question presented. If it did not, the action taken, being beyond the authority granted, was invalid. The only power to make any recapture order arose from the statute.

The judgment of the court below must be reversed. A decree will be entered here annulling the challenged order.

Dissenting Opinion

In a dissenting opinion Justice Stone expressed the views of the minority of the court. He said in part:

The report of the Interstate Commerce commission is rejected and its order set aside on the sole ground that in a recapture proceeding under Section 15 (a) of the Interstate Commerce Act, it has failed to consider present reproduction cost or value of appellant's property and so to "give due consideration to all the elements of value recognized by the law of the land for rate making purposes." No constitutional question is involved.

* * *

I cannot avoid the conclusion that in substance the objection, now upheld, to the order of the Commission is not that it failed to consider or give appropriate weight to evidence of present reproduction cost of appellant's road, but that it attached less weight to present construction costs than to other factors before it affecting adversely the present value of the structural property. That this was the real nature of the objection voiced by the dissenting Commissioners seems to me apparent from their opinion. They seem to assume that as a result of Southwestern Tel. Co. v. Public Service Comm., 262 U. S. 276, and other cases in this Court, the Commission as a matter of law may never, under any circumstances, find that the value of the structural part of a railroad does not exceed its fair value of an earlier date, if the Commission has before it evidence of later increased construction costs. They say "under the law of the land," in valuing a railroad under section 15a "we must accord weight in the legal sense to the greatly enhanced cost of materal, labor and supplies" during the recapture periods. Weight in the legal sense is evidently taken to be not that accorded by an informed judgment but imposed by some positive rule of law.

* * *

This Court has said that present reproduction costs must be considered in ascertaining value for rate making purposes. But it has not said that such evidence, when fairly considered may not be outweighed by other considerations affecting value, or that any evidence of present reproduction costs, when compared with all the other factors affecting value, must be given a weight to which it is not entitled in the judgment of the tribunal "informed by experience" and "appointed by law" to deal with the very problem now presented. *Illinois Central & R. R.* v. *Interstate Commerce Commission*, 206 U. S. 441, 454. But if "weight in the legal sense" must be given to evidence of present construction costs, by the judgment now given we do not lay down any legal rule which will inform the Commission how much weight, short of its full effect, to the exclusion of all considerations, is to be given to the evidence of synthetic costs of construction in valuing a railroad property. If full effect were to be given to it in all cases then, as the Commission points out in its report, the railroads of the country having in 1919 a reproduction cost or value of $19,000,000,000 would now have a value of $40,000,000,000 and we would arrive at the economic paradox that the present value of the railroads is far in excess of any amount on which they could earn a return. If less than full effect may be given, it is difficult for me to see how, without departure from established principles, the Commission could be asked to do more than it has already done—to weigh the evidence guided by all the proper considerations—or how, if there is evidence upon which its findings may rest, we can substitute our judgment for that of the Commission. Such, I believe, is the "due consideration" which the statute requires of "all the elements of value recognized by the law of the land for rate making purposes."

* * *

Concur in Dissenting Opinion

Justice Holmes and Justice Brandeis concurred in this dissenting opinion.

Justice Butler took no part in the consideration or determination of the case.

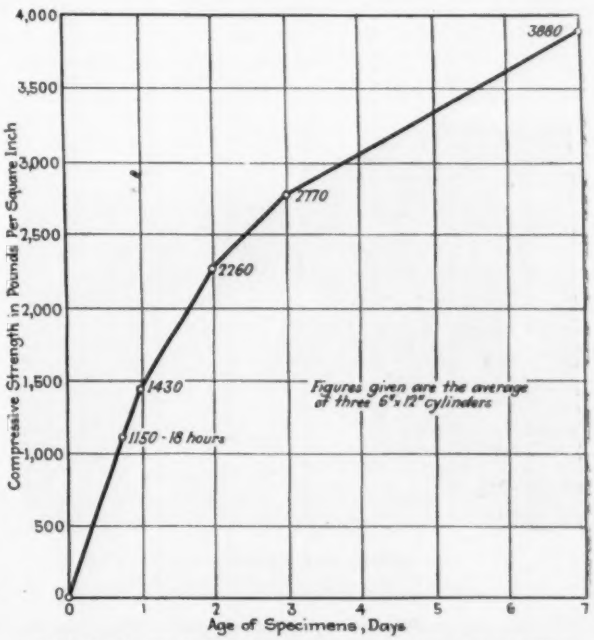
Standard Cement Concrete Pavement Opened in 48 Hours

By Earle W. Meckley
City Engineer, Allentown, Pa.

In paving about 2,000 sq. yd. on Hanover Ave. at the east end of the Hamilton St. bridge in Allentown, Pa., in September, 1928, the standard concrete mixture by very ordinary manipulation was made strong enough to take traffic the second day after placing.

The specifications required, as for all other concrete paving, that a 1:2:3 mix be used with a 1¼-minute mixing period. Inspectors saw that the full mixing period was used on all batches and that the concrete was placed as dry as would permit satisfactory working.

Concreting started at 9 a. m. Sept. 8. The water content ran close to 5¼ gal. per bag of cement exclusive of that carried by the aggregates, the calcium chloride content was at the rate of 2 lb. per bag of cement, the slump



COMPRESSIVE STRENGTH OF CONCRETE CYLINDERS

averaged 3 in. consistently, and the temperature for curing averaged 65 deg. for a 24-hour period. Test cylinders were taken at 4:30 p. m. and cured at the road side. Wet burlap was used as a covering.

The results of tests made of cylinders are shown in the accompanying chart. The 48-hour average strength of 2,260-lb. per square inch was considered ample to permit immediate use of the road. It was opened to traffic at 5 p. m. on Sept. 10.

For the purpose of visually demonstrating the strength, the contractor Geo. M. Hardner, ordered a truck and load, a total weight of 14 tons, to proceed over this pavement when it was 18 hours old. As an added and more severe test, one rear wheel of the truck was brought to rest upon a small angle iron where it stood for about five minutes while being photographed. Thus a load of 4⅔ tons (⅓ total weight of truck and load) was concentrated on two knife edges 24 in. long. An examination of the pavement at the time of loading and subsequently indicated that no fracture occurred.

Interlocking Precast Forms Used in Making Concrete Seawall

Experimental Type of Shore Protection Combines Flexibility, Low Cost and Resistance to Wave Action During Construction

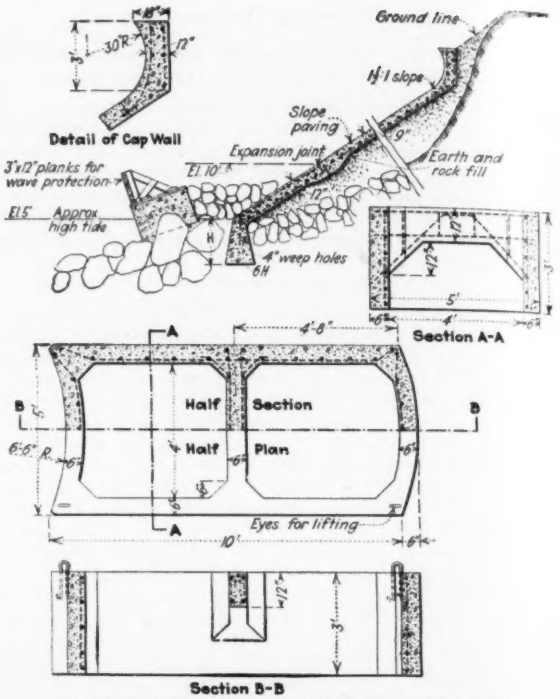
IN CONSTRUCTING a new state highway along the Pacific Ocean in Ventura County, California, it was necessary to construct some form of shore protection at many points where waves roll in against the toe of slopes close to the roadway. The California Division of Highways has been working on this project for several years and thus there has been opportunity for observation of the points that require protection and also time to work out a construction scheme that would be feasible under the difficulties attending placing heavy concrete works along or below the tide line.

The method of protection finally adopted consists of placing a row of precast concrete cells approximately at high-tide elevation and filling them with concrete. The cells are without bottoms and act merely as forms allowing the concrete to flow in among the rocks below, consolidating the cells and rocks into a wall. The concrete wall thus built serves primarily as a footing or toe wall to provide support for the lower end of the subsequent slope paving. In addition it provides a buffer against wave action, especially during the construction of the slope paving. The reason for selecting precast cells in lieu of ordinary forms will be apparent from the accompanying illustrations showing the physical conditions encountered.

TYPICAL SHORE LINE TO BE PROTECTED
Cells on slope ready to be placed in position.

About 300 of these cells have been used thus far in this work. They are of rectangular shape, 5x10 ft. in plan and 3 ft. high, with 6-in. walls, and weigh about 3 tons. The main reinforcing consists of ⅜-in. square bars 9 in. on centers in both directions. Eyes are provided at the corners for handling. The ends are curved to a radius of 6½ ft., giving an interlocking effect to provide stability against wave action. The size was determined as being about the maximum for convenient handling with a stiff-leg derrick. The concrete forming the cell walls contains seven sacks of cement per cubic yard.

The cells were cast on the highway right-of-way as close as practicable to the seawall site, using a portable concreting plant which was moved as the work progressed. The plant was moved nine times to pour the 3,000 lin.ft. of cells used along the 7-mile stretch of shore line; the cost of these moves, which involved an average haul of about a mile, was about $500 each.

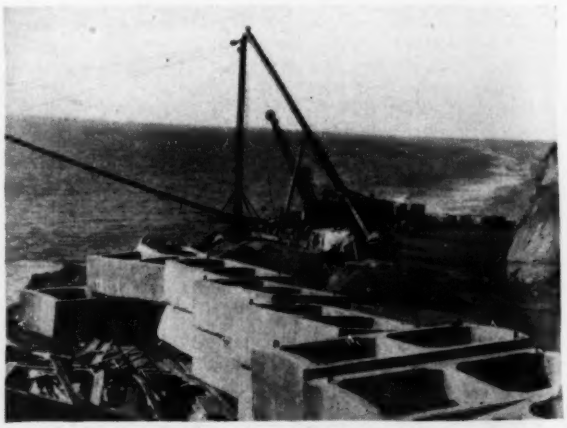


GENERAL LAYOUT OF PROTECTION WORK AND DETAILS OF CELL

Removable forms were built of ordinary tongue-and-groove flooring and were well oiled between pours. To provide replacements for possible breakage of the forms, sixteen sets were built, although the usual cast consisted of twelve cells. The durability of the forms is shown by the fact that about twenty cells have already been poured per form.

In preparation for placing the cells, small boulders were cleared away by hand or with the aid of a derrick. Whenever possible, advantage was taken of large boulders that would project up into the cells, or such rocks were moved into position by the derrick to help consolidate the concrete with the natural rock of the shore.

In most of the locations it was possible to get a stiff-



DERRICK WITH 70-FT. BOOM LOWERS CELLS TO POSITION
Raising the mast with the shovel, the derrick is moved as the work progresses.

leg derrick into position on the highway so that a 70-ft. boom could swing the precast cells from their position on the roadway into place in the seawall. The derrick was built so that motive power could be supplied by a power shovel moved underneath the derrick frame with its cables passed around the bull-wheel and through the sheave. The derrick was moved by taking the railroad-iron weights off the legs and using the same shovel employed in its operation to move it along the roadway. A wheel built into the derrick frame under each leg made it possible to do this with the shovel itself supporting only the portion of the derrick weight that centered at the mast.

After the cells were in place they were filled with rubble concrete containing 4.2 sacks of cement per cubic yard. Immediately before filling, a row of 6x6-in. timber uprights was placed in the cells along the offshore wall to be embedded in the concrete. After the concrete had set, a 3-ft. plank parapet was built on these posts to protect workmen on the toe wall and slope paving from the waves. This bulkhead also protected the fresh concrete of the slope wall from wave action. The planks were later removed and the posts cut off.

Where tide levels permitted, concrete was also placed beneath and in front of the cells, filling in between the boulders, more thoroughly to consolidate and strengthen the wall. This work was done down to the low-tide level during quiet periods when the tide was out. One sack of hard wall plaster was added for each six sacks of cement in making the 1:4-mix concrete used for this purpose, as well as that forming the top layer in the cells. The plaster was used to form a quick-setting concrete increasing resistance to wave action by the time the first high tide came in.

In some locations, in order to gain sufficient height, it was necessary to set the cells in receding tiers up the slope. Dowels of 1-in. square rods 4 ft. long were placed between the rows and the whole structure was filled with concrete.

CELL PLACING UNDER DIFFICULTIES

FINISHED SECTION OF SHORE PROTECTION WORK
Toe-wall and wave buffer of precast cells, slope paving and throw-back cap.

The cost of preparing the foundation, building the precast cells and filling them with concrete has averaged about $18 per linear foot. The cost of the shore protection complete, including a 20-ft. height of wall (measured on the slope) behind the cells, averages from $25 to $30 per front foot. Based on these costs, it was estimated that if the work remained in place through only one winter it would save more than the road reconstruction costs that otherwise would have been necessary. At the end of the first winter season just past, the shore protection is reported by state highway engineers to have withstood wave action, including one rather severe storm, without sign of damage to or weakness in the protecting units.

The work has been done by crews employed by the State Highway Commission in charge of M. L. Sullivan, superintendent, working under the general supervision of S. V. Cortelyou, division engineer at Los Angeles. C. H. Purcell is state highway engineer.

Air Mapping of Alaska Under Way

A second air-mapping expedition is being sent to southeastern Alaska to continue the photographic coverage of this region, it is announced by the Navy Department. Three Loening amphibian planes will be used, with the U. S. S. "Gannet" as tender. The aerial and photographic unit of 35 men together with their equipment will be carried on a barge. Lieut. Commander A. W. Radford will be in carge of the expedition. R. E. Sargent, a topographic engineer of the U. S. Geological Survey, who is familiar with the country, will represent the departments of Interior and Agriculture in an advisory capacity.

The photographic ground plan will be used by the Geological Survey in topographic mapping and by the Forest Service in estimates of timber resources. In 1926 air photos were made of 10,000 square miles near Ketchikan. It is stated that the development of this region for pulpwood has been set forward many years by this means. In spite of the difficulties of travel and the short field seasons, about 45 per cent of the area of Alaska has already been covered by topographic maps, the progress being as great as that in the United States. Most of the existing maps are of interior regions, attention now being turned to areas nearer the coast.

Tunneling a Water-Bearing Fault by Cementation

Special Grouting Process Employed in Driving Underground Slope in Shannon Mine in Alabama Through Badly Crushed Wet Fault Which Had Stopped Normal Drifting to Main Ore Seam Beyond

By J. S. Crawhall
The Dravo Contracting Company, Pittsburgh, Pa.

HIGH-PRESSURE grout injection by the François cementation process was employed last year to carry a slope drift through a shattered, water-bearing fault in the Shannon mine of the Gulf States Steel Co., near Birmingham, Ala. The mine workings are located at great depth under Shades Mountain and entrance is by an inclined shaft at the foot of the mountain. This shaft ends underground at a loading pocket in the main drift, Fig. 1. From the main roadway, slopes *A* and *B* followed the dip of the ore seam and later slope *C* was run after drift 6 north from slope *B* had been advanced. These three parallel slopes are the haulage ways out of the mine.

Fault Stops Slope Drifting

In March, 1925, slope *A*, which had been showing roof seepage, struck about 40 gal. per minute in the face. Diamond drill holes were then advanced in slopes *A*, *B* and *C*, all of which proved the existence of a waterbearing fault as shown in Fig 2. The characteristics of the problem were:

1. The registered gage pressure of the water in slope *B* was not less than 950 lb. per sq.in.
2. When a number of drill holes in slope *A* were open simultaneously, about 100 gal. per min. flowed and the pressure dropped considerably.
3. Heavy flows of pyritic mud and pebbles totaling several tons accompanied by sulphureted hydrogen gas rushed out of the boreholes at intervals.
4. The fault proper varied between 4 and 8 ft. in thickness.

Owing to the limitations of the main slope for accomodating pump columns, and fear of a severe flow of water and mud and its attendant danger of indefinite caving, pumping was not feasible. To sink another shaft beyond the fault would cost at least $1,500,000. As one of the mine managers had inspected François cementation work in England, attention was given to the possibility of adopting this process, and finally a contract was negotiated as described later.

Cementation Process

In the François process cement grout instead of being blown intermittently by direct air pressure and in thick soupy form is pumped into the rock through boreholes in a steady stream by pumps which will develop pressures of 3,000 lb. per sq.in. if required. The grout is exceedingly thin when injection is started and is gradually thickened as the pressure will allow. Whenever rock does not accept liquid cement readily, (due to fine fissuration, sand filling the fissures, pores or other causes), it is treated by chemicals. Under a patented process, silicate of soda and sulphate of aluminum are injected as two independent clear solutions; they meet in the rock and form a colloidal precipitate which lubricates the fissures with a jelly-like substance and, along with the subsequently injected cement, sets and forms a water-tight filling.

Apart from the extensive record of successful work in mining operations, civil engineers have utilized the cementation process in such work as pretreating the rock of the new Mersey Vehicular Tunnel—44 ft. in diameter—now under construction under the River Mersey between Liverpool and Birkenhead; the restoration of the piers of St. Paul's Cathedral in London; the treatment of sand and gravel deposits for the deep London subway tubes; and the treatment of dam sites prior to construction, together with the sealing of leakages from existing dams. At present the François cementation process is in use by the Italian government to prevent further subsidence in the Leaning Tower of Pisa by consolidation of the foundation gravel deposits.

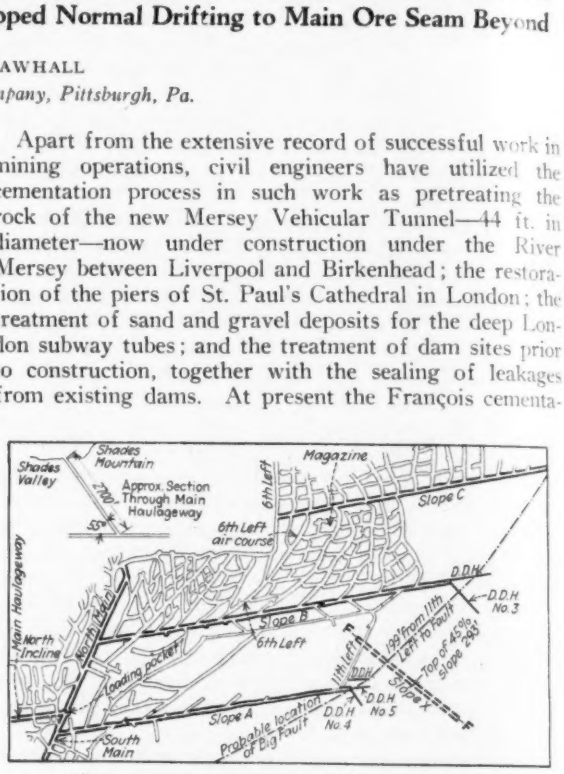


FIG. 1—SHANNON MINE WORKINGS SHOWNG FAULT ZONE AND SLOPE DRIFT PENETRATING IT

Procedure at Shannon Mine

The Dravo Contracting Company, which has the American rights for the process, contracted with the owner of the mine to drive two tunnels 11 ft. in finished diameter through the fault and thereafter to continue slopes down to the big seam beyond, no payment to be made to the contractors until the fault was successfully traversed. Owing to the disturbance created by previous grouting operations, which would have necessitated the construction of an elaborate bulkhead in slope *A*, it was decided to attack the fault at a new point intermediate between slopes *A* and *B*.

The general plan was to advance the new slope to a point about 50 ft. from the fault in a horizontal direction, where it was expected there would be about 35 ft. of overhead protection. From this point a series of drill holes would be put out in cone shape to intersect the fault plane on a diameter of 40 ft. Each drill hole as soon as it tapped water would be injected with grout up to a pressure of 2,500 lb., cleaned out, reinjected and finally treated with chemicals until the water was completely sealed off. This would create a grout zone around the proposed tunnel line. A pilot heading 8 x 8 ft. would then be driven through the grouted area into the limestone beyond, the tunnel enlarged and permanently lined.

All drilling was done with two turbo-rotation deep-hole drills with 2⅜-in. bits, through 2½-in. steel pipes inserted and securely grouted into the rock. The pipe holes were drilled 12½ ft. deep, care being taken to pitch them at the correct angle, and a 13-ft. pipe was inserted and calked into each with old hemp rope. Then grout was introduced at 400 lb. This was allowed to set for eight hours, when the pipe was cleaned out and bored through and beyond 6 in. into solid ground. The pump was again applied and the hole tested to 2,000 lb. Then the pipe was ready for the drilling to be extended as far as required for grout injection.

Two pumps were used, a 3-in. with a maximum capacity of 7 tons of cement per hour and a 2-in. with a maximum capacity of 3 tons per hour. To prepare the grout, the cement was mixed with water in the required proportions in a tank elevated 4 ft. above the pump, whence it was run through a sieve into a similar tank at ground level. Agitators driven by a small compressed-air engine ensured a uniform mixture. The suction of the pump was from the lower tank and the grout was delivered into a pipe and through a heavy armored rubber hose into the borehole standpipe, which in turn was fitted with an extra-heavy cast steel plug-cock.

The sodium silicate and aluminum sulphate, prepared in solutions of the required dilutions, were pumped through separate pumps and allowed to meet at the entrance to the standpipe, where they reacted, and the resultant colloidal precipitate was forced along the boreholes into the fissures.

Large Fault Successfully Grouted

Information furnished by the mine owners showed that the fault would be reached about 165 ft. along the slope. Accordingly, at 117 ft. (Fig. 2) excavation was suspended and preparations were made to carry out the proposed cementation treatment. Four holes were drilled. The first change of ground was noted at 150 ft., when a gusher of water, gas and black mud was struck in one of the holes. This subsided to a steady stream of clear water, and the hole was drilled to 205 ft. before it encountered real evidence of fault conditions.

It was concluded that a change in the direction of the fault had caused a disturbance at 150 ft. but that the main fault lay at 205 ft. Four more boreholes were drilled through the changed ground at 150 ft., making eight in all, and these were treated individually with cement injections to 2,000-lb. pressure to make them absolutely dry. Excavation was then continued on an 8 x 8-ft. heading, the pyritic material was safely passed without leakage, and a new program of cementation was commenced from 157 ft. This time eight boreholes (Fig. 3) were disposed to cut the fault on a diameter of 40 ft., with two test holes drilled at the conclusion of the treatment.

Cement was not readily accepted by the fault, but was ultimately forced in under final pressures of 2,500 lb. Lastly, all holes were treated with chemicals to search out the fine fissures, and a further injection of cement was taken as a result of the lubricating action. Of the two test holes which were drilled, one was quite dry and the other showed only a trace of water, indicating the success of the operation and showing that it was safe to resume excavation on an 8 x 8-ft. section and pass through the fault to the limestone beyond.

Great care was taken with shot firing as the fault was approached and crossed, but the cementation was found to have sealed all water with the exception of ⅛ gal. per min. The chief source of danger now lay in caving ground. This was not found serious, however. The fault material was a mixture of shale, mud and distintegrated iron pyrites, with an intermixture of pebbles and breccia.

Second Water-Bearing Zone Struck

The heading at this stage had clearly passed the fault, and the work proceeded through the transition section (Fig. 2) from the grout zone into the zone of contemplated dry excavation ahead. Pilot holes were carried forward in the limestone from the hanging wall of the fault at 212 ft. to the point where the grade of the slope changed at 293 ft. No sign of water was found and the driving was continued safely to 293 ft.

At 305 ft. the night shift of drillers suddenly tapped a flow of water in a drill hole 7 ft. beyond the face. At first the flow was small, but while arrangements were being made to deal with it the entire electric lighting system of the mine unfortunately went out of commission for a period of 20 minutes. The water meanwhile continued to increase in volume, and in two hours —by which time the cementation foreman was brought underground—the face was entirely flooded by a feeder estimated at 300 to 400 gal. per minute. This was on June 15, 1928; work had been in progress since Feb. 22.

Shannon Mine was equipped with only one pump of 100 gal. per minute capacity, which normally dealt with 50 gal. per minute of mine water and leakage at slope *A*, so that very little relief could be sought in that quarter . Nor could extra pumps be had from stock to work against a 2,200-ft. head. The two 10-ton ore-hoisting skips were resorted to, as they could deal with about 150 gal. per minute by installing a tank and sluice valve at the bottom of the slope for quick filling, which arrangement was put into force by June 17. Workings lying below the entrance to the slope were available to store surplus water for an estimated period of 16 days, after which the mine would be flooded beyond hope of recovery except by elaborate shaft pumping installations if this further water could not be sealed off.

For nine days the battle was fought with what air-

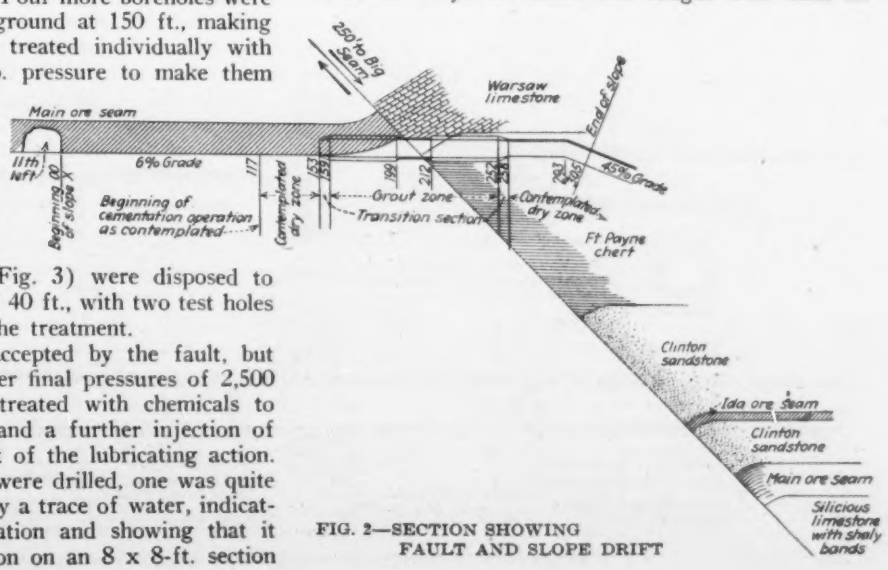


FIG. 2—SECTION SHOWING FAULT AND SLOPE DRIFT

driven pumps could be immediately obtained, to get the face cleared of water and sulphur dioxide and sulphureted hydrogen gases which were liberated from the water, particularly when it was broken into spray. The men suffered severely from sore eyes and throats, and few could continue workings even with goggles supplied by the Bureau of Mines safety department.

However, by June 24 ventilation had been improved, the water had been cleared by the pumps delivering to the mine workings, and—more important than all—a second drill hole had been made with a 2½-in. standpipe securely grouted in, which relieved the pressure sufficiently in the first drill hole to permit a pipe to be driven into it. Thus all the water except some 15 gal. per minute leakage was being piped away from the face and delivered directly to the lower mine workings without the help of pumps, though by this time it was estimated that the feeders amounted to 400 or 500 gal. per minute.

An attempt to grout the feeders directly would have invited disaster. A pressure gage on a diamond drill hole in slope *B* 700 ft. away had dropped from 950 lb. to 900 lb., showing that the water there was connected with that in the new flow and therefore under the same pressure. If the valves were closed the enormous load of 68 tons per sq.ft. or a total of 9,180 tons was liable to come on a limestone face 15 ft. wide by 9 ft. high and with a fissure evidently extending over the whole area only 7 ft. away. The writer therefore decided to build a dam on principles which he had previously employed successfully, but never against such an enormous pressure.

The construction of this dam was carried out in 60 hours, and completed on June 27. Reference to Fig. 3 shows the dam divided into two sections, ignoring the third portion added on Aug. 8 as a precaution against the possibility of defective valves. An 18-in. brick wall 7 ft. from the face laid in cement mortar, was built; 8 ft. behind this a second wall laid to arch shape served to confine concrete filling between the two walls, while the front section was filled with hand-placed rock. Eight cement injection pipes 2½ in. in diameter were laid in the dam as construction proceeded, and two of these reached the highest points of the rock fill to draw off all air.

It was impossible to get any proper aggregate into the mine without stopping water hoisting, and as the shot limestone rock from the heading still remained underground in cars it was used with only cement and a little sand brought down the main hoisting slope. Quick-hardening cement was used, and as the temperature was 89 deg. this set quickly.

On June 28, 130 bbl. of neat cement were injected into the rock fill to a pressure of 200 lb., still leaving the water free egress through the two pipes in the face. The same leakage of 15 gal per minute around the pipe of the original drill hole made its appearance over the dam and defied efforts to seal it for 36 hours. By this time the concrete had reached considerable strength, so that a plan of grouting could be undertaken. Six sacks of cement and sawdust were forced at 800 lb. up the pipe leading to the original drill hole. The effect was immediate, and all leakage was sealed.

On July 1 all the water was flowing out of the 2½-in. pipe inserted in the second drill hole. The 3-in. cementation pump was coupled to this at a registered pressure of 810 lb., and grouting was commenced with neat cement. In spite of some 9,000,000 gal. drawn off, there was only a pressure drop from 950 to 810 lb., with no apparent diminution of flow. One can only hazard a guess as to the tremendous volume of water that would have been liberated if this water-bearing fissure had lain 2 ft. further ahead and the face had been blasted. The first injection of the fissure took 205 bbl. of cement without any increase of injection pressure above 840 lb., so at this stage the valve was closed to allow the cement to set.

A Herculean task had been accomplished—the dam held tight and the mine was saved. It was however, only the first task, and a more uncertain problem was still to be handled and solved. The fissure, fault or whateved it might be, had to be sealed before the tunnel might be advanced to the ore. Between July 2 and July 14, no less than 851½ bbl. of cement, together with some limestone dust, were pumped into the fissure before definite signs of filling were seen. In the meantime No. 3 hole had been drilled through the dam into the fissure. This hole first struck a flow of some 50 gal. per minute, and 1 ft. beyond there was literally an explosion which caused several men to run for their lives. Amid a terrific roar of water, the steel had become stuck in the 2¼ in. drill hole, and when the foreman struck it with a hammer it flew out of the hole in a streak of fire

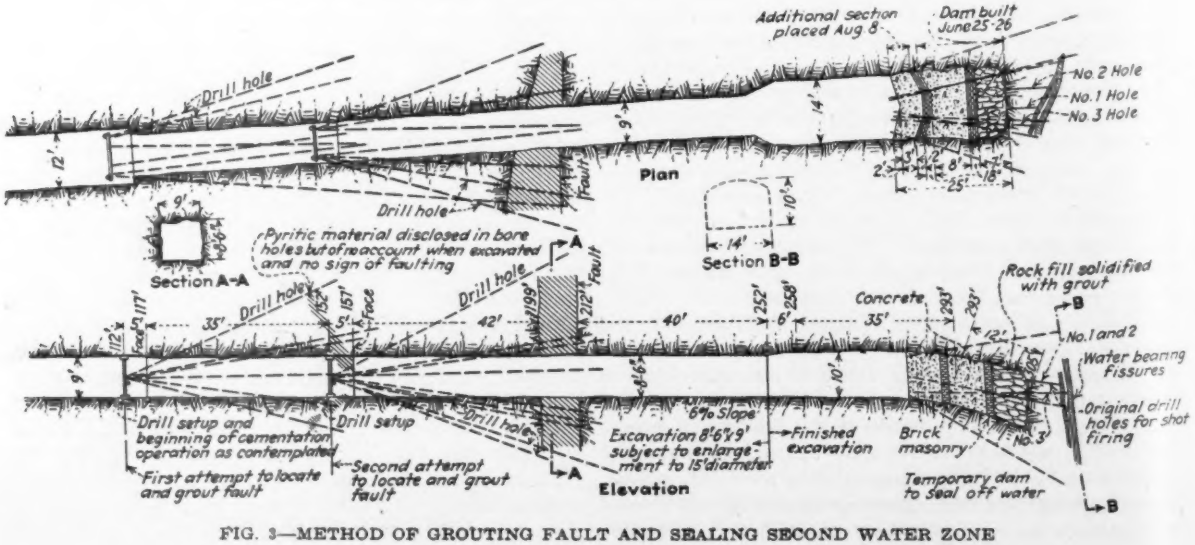


FIG. 3—METHOD OF GROUTING FAULT AND SEALING SECOND WATER ZONE

and shattered as it struck the rock sides of the drift 30 ft. back. The valve had not, however, been damaged, and with 600 gal. per minute rushing out the foreman closed off the water. When one considers a city fire hose jet of perhaps 1¼ in. diameter, and multiplies the volume and speed of the jet by about six, one begins to appreciate the conditions in the Shannon mine workings at this time.

A temporary suspension of work occurred between July 14 and 22, when a program consisting of drilling six holes on a cone round the dam was undertaken to intercept the fissure at points far enough away from the line of the drift to permit safe excavation of the tunnel. All these holes cut the fissure, but with little or no water; so that the further injection of 176 bbl. of cement had to be put in at increased pressure, to tighten up the water zone.

The question of exploring the entire strata by a diamond drill hole and further extension of the tunnel is deferred, owing to differences between the contractor and the owners as to whether the latter should make payment for the work already done, and for any possible extension of cementation operations in the event of encountering further unexpected water.

Directing Personnel

The Gulf States Steel Company, owner of Shannon mine, was represented in this work by L. E. Geohegan, vice-president and general manager, and the Dravo Contracting Company of Pittsburgh executed the work under the direction of E. T. Gott, vice-president, with the author as technical advisor.

It is believed that never in the history of mining has water been encountered in such volume and under such pressure, and it is certain that no organization has ever previously succeeded in stopping an underground flow under such conditions.

Committee to Study Economic Features of Channel Tunnel

The British government has set up a special committee of the committee of civil research to conduct an impartial inquiry into the economic aspects of the proposed Channel tunnel and other schemes of cross-Channel communication, according to *The Engineer,* London. This committee will pass upon the economic aspects of the project before the military aspects are considered, so that the government will have a definite basis against which to offset the probable disadvantages of the project from a military point of view. The committee will consist of E. R. Peacock and Sir Henry Strakosch, bankers; Lord Ebbisham, a printer; Sir Clement Hindley, an engineer, and Sir Frederick Lewis, a shipowner.

Flood Flows in Southwestern Kansas in November, 1928

Studies of Runoff on Osage, Neosho, Verdigris and Walnut Rivers—Record Flood Stages Considerably Exceeded

By J. B. Spiegel
District Engineer, U. S. Geological Survey
Topeka, Kan.

"RAIN probable tonight and Friday" was the laconic forecast of the Weather Bureau on Nov. 15, 1928. The rain began at 8 p.m. and for about 36 hours thereafter fell over the entire eastern half of Kansas and beyond its borders. During that period 4,500,000 acre-ft. of water, an average depth of 6.5 in., started to move toward the state borders from the 12,800 square miles (Osage, Neosho, Verdigris and Walnut basins) that received most of the precipitation. The rainfall was also heavy in the Kansas River basin, but at Bonner Springs, Kan., near the mouth of the Kansas, the maximum discharge of 65,000 sec.-ft. filled the channel to only 65 per cent of its capacity.

SECTION OF FEDERAL-AID HIGHWAY NEAR TRADING POST, KAN.

The highway is just emerging from the floodwaters of the Osage River.

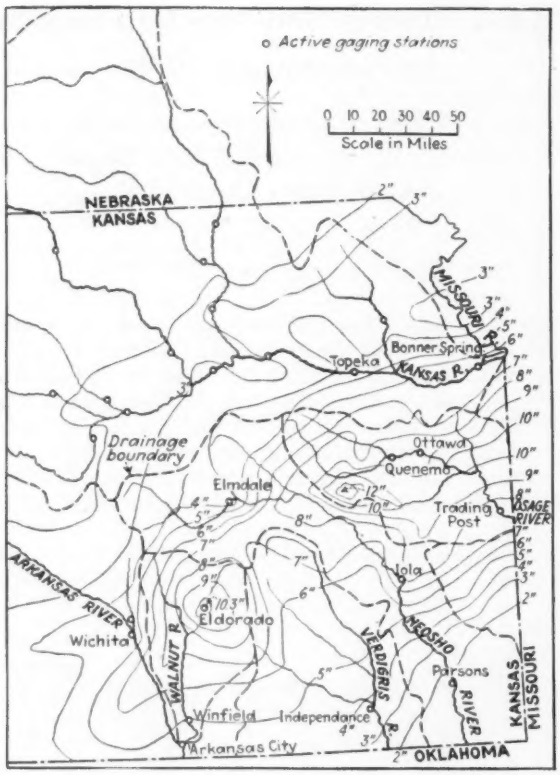
The precipitation records indicate that the depth of rainfall in this area was that shown by the isohyetal lines on the accompanying map. The unprecedented high stages of the Walnut and Osage rivers prove that the heaviest rains fell in their basins. In addition to the extremely high precipitation of 10.3 in. at El Dorado and 11.2 in. at Lebo, a total of 10.75 in. was recorded at Paola. An unofficial observation of 14 in. was reported for the Walnut basin.

Gaging stations on streams draining the area affected

PERTINENT DATA CONCERNING FLOODS IN KANSAS IN NOVEMBER, 1928, ON OSAGE, NEOSHO, VERDIGRIS AND WALNUT RIVERS

River	Gaging Station	Drainage Area, Sq.Mi.	Precipitation—Depth In.	Precipitation—Ft.	Volume, Acre-Ft.	Runoff, Acre-Ft.	Max. 24-Hr. Runoff as Per Cent of Total Precipitation	Total Runoff as Per Cent of Total Precipitation	Max. 24-Hr. Runoff as Per Cent of Total Runoff	Maximum Recorded Stages in Feet, November, 1928 Stage	Date	Previously Recorded Stage	Date	Maximum Discharge November, 1928, Sec.-Ft. Total	Per Sq.Mi.
Osage	Ottawa	1,250	8.15	0.68	544,000	313,000	19	58	37	38.65	Nov. 17	37.0	July, 1909	58,600	47
Osage	Trading Post	3,230	8.65	0.72	1,485,000	1,137,000	19	76	24	34.45	Nov. 18	32.0	July, 1909	140,000	43
Osage	Between Ottawa and Trading Post	1,980	9.00	0.75	941,000	804,000	29	85	34	34.45	Nov. 18	32.0	July, 1909	.....	..
Neosho	Parsons	4,860	5.80	0.48	1,375,000	687,000	7	50	14	27.53	Nov. 24	27.45	Apr., 1927	48,400	10
Verdigris	Independence	2,800	6.50	0.54	1,203,000	396,000	9	33	28	43.93	Nov. 19	46.04	Oct., 1927	70,100	25
Walnut	Winfield	1,860	7.60	0.63	754,000	451,000*	38*	60†	63*	40.61	Nov. 18	38.7	June, 1923	160,000	86

*Based on the gage-height graph at Winfield and the estimated total runoff as 60 per cent of the total precipitation.
†Comparable to discharge passing Ottawa, Kan.



ISOHYETAL MAP OF NOV. 15-17, 1928

by this storm are maintained by the U. S. Geological Survey on the Osage at Ottawa, on the Neosho near Iola and Parsons, on the Verdigris at Independence, and on the Walnut near Winfield, in co-operation with the Kansas Division of Water Resources, and on the Osage near Trading Post, in co-operation with the Kansas City office of the U. S. Engineer Corps. Measurements of discharge and other data needed for computing the flood flow at these stations were obtained by engineers connected with the two services just mentioned.

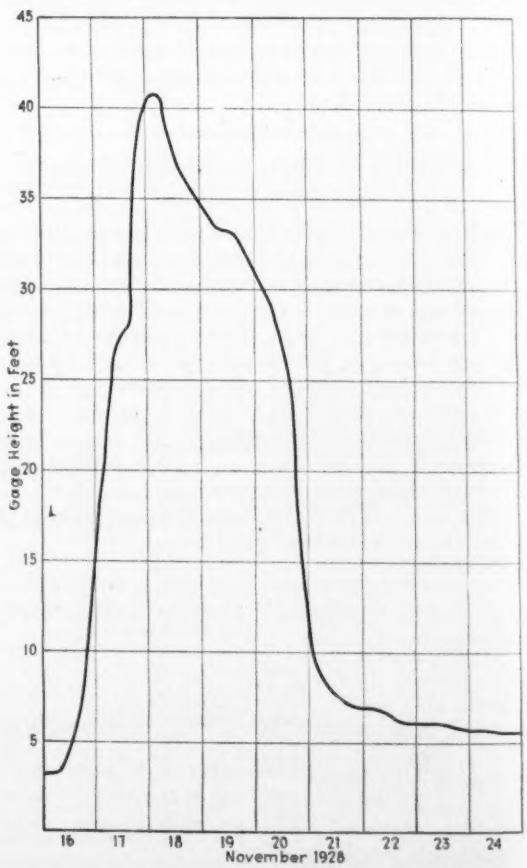
It had become the generally accepted belief that the 37-ft. flood stage of 1909 on the Osage at Ottawa was about as high as might reasonably be expected, yet from 7 to 10 p.m. on Nov. 17 that stage was exceeded by 20 in. At Main Street, Ottawa, the river was 2,860 ft. wide. At Trading Post the maximum stage of the river was 30 in. higher than the previous maximum, 32 ft. in July, 1909. Highway engineers will be interested to know that the federal-aid highway, 2 miles long, across the Neosho Valley stood the test well. For about 72 hours water passed over the fill in depths as great as 30 in. It is estimated that the maximum discharge for Big Sugar Creek was between 40,000 and 50,000 sec.-ft.

The low maximum runoff of the Neosho near Parsons is due mostly to the shape of the drainage basin and a lower rainfall, the heaviest being 9 in. along a narrow strip on the northeast side. In the Neosho Valley near Parsons, Kan., traffic on the federal-aid highway was undisturbed, and this highway furnished an excellent place for making several measurements of the entire flow. However, elsewhere in the stricken area highway traffic was blocked from one to eight days. It was found that the average velocity of the overflow of the Neosho River near Parsons, where the width was nearly 2 miles and the depth about 3 ft., was 0.56 ft. per second.

The Verdigris River at Independence failed to reach its record height of October, 1927, by about 26 in. At its highest stage in November, 43.93 ft., the water covered—for a short time only—about 2,800 ft. of roadway between the bridge and the city.

Because of inadequate personnel no discharge measurements were made on the Walnut River at Winfield, but the faithful gage reader at that station furnished a fairly good record of stage. The hydrograph constructed from this record is presented herein. From the meager field data an estimate has been made of the probable average daily and maximum flow of the Walnut River at this station during the period when it was out of its banks. The stage-discharge relation at Winfield is fairly well defined by current-meter measurements up to 31 ft.—a little above bankfull stage. After studying the magnitude of flood discharges from the other basins it was concluded that for the Winfield station the ratio of total discharge to total precipitation would probably correspond closely to that which occurred at the gaging station on the Osage River at Ottawa. The ratio chosen to be applied to obtain the probable volume of discharge for the 4½-day period of the flood at Winfield was 60 per cent.

The extension of the rating curve to obtain the maximum and average discharges during the two days of highest average runoff was done by estimating the discharge for the lower of the two days to be 40,000 sec.-ft. As the average stage for that day was only 3 ft. above the stage for which the rating curve is defined by current-meter measurements, the error involved is believed to be not more than 10 per cent. By subtracting the discharge thus determined from the assumed total discharge



RECORD OF THE GAGE READER AT WINFIELD FOR NOV. 16 to 24

the average maximum 24-hour discharge was found to be 142,000 sec.-ft.

The gage at the Winfield station is attached to the upstream side of a concrete arched highway bridge. The obstruction of the water at so high a stage created a pressure head at the upstream side of the bridge and so produced a reversal in the rating curve. Extension of the curve through the point determined by the 39-ft. average stage and corresponding average discharge of 142,000 sec-ft. indicates a maximum flow of approximately 160,000 sec.-ft. This discharge is equivalent to 86 sec.-ft. per square mile of drainage area, thus considerably exceeding the corresponding results on other streams, as shown in the accompanying table summarizing flood data pertaining to this storm.

Surveys are now being made by the Burns & McDonnell Engineering Company for the city of Winfield that may bring to light additional information.

Laboratory Tests on Arc-Welded Latticed Steel Columns

Based on Results With Test Specimens, Members Carry Loads Exceeding Designed Strengths—Lines of Strain Diagrammed

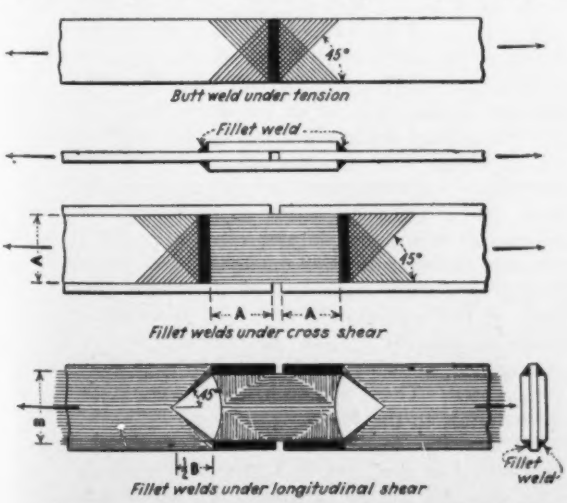
By B. M. Shimkin

Engineer, California Steel Products Company, San Francisco, Calif.

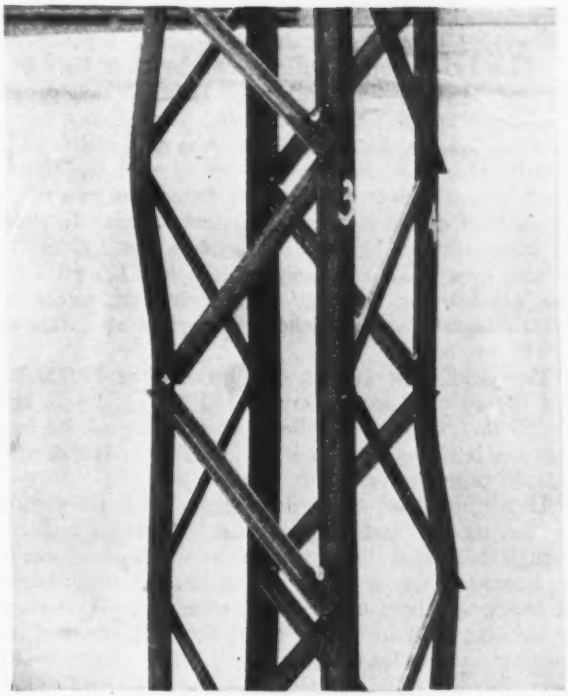
A SERIES of tests on arc-welded box beams and latticed columns made by the writer in the testing laboratory at the University of California at Berkeley in connection with thesis work gave the following results:

The unit strengths allowable in fabricating the beams and columns were first obtained by testing specimen welds. Forty-one butt welds on $\frac{3}{8}$- and $\frac{1}{2}$-in. plate developed tensile strength of from 40,000 to 56,000 lb. per sq.in., with an average of 45,610 lb. Welds of this type made by an inexperienced welder gave tensile strengths varying from 30,700 to 47,600 lb. per sq.in.

Fourteen specimens of $\frac{3}{8}$- to $\frac{1}{2}$-in. fillet welds parallel to the line of pull developed shearing strength, referred to in the following as longitudinal shear, of from 7,500 to 11,700 lb., averaging about 10,000 lb. per linear inch. This reduces to unit strength in longitudinal shear of 22,200 to 33,700 lb. per sq.in.



DIAGRAMMED STRAIN LINES FOR ARC-WELDED JOINTS OF THREE TYPES



WELDED LATTICED COLUMN AFTER TESTING
Note typical leg failure between lacing.

Another set of fourteen fillet welds of the same size normal to the line of pull developed shearing strength, referred to in the following as cross shear, of 9,820 to 15,250 lb. with an average of about 12,200 lb. per linear inch. The average strength of the welds under cross shear was 23.4 per cent higher than welds subjected to longitudinal shear. The yield point as indicated by the drop of the beam averaged 82 per cent of the ultimate strength. The ratio of shear to tensile strength was 0.61 and 0.80, respectively, for longitudinal and cross shear.

Based on these strength values for arc-welded joints, structural beams and columns were designed, fabricated and tested to destruction. Three box beams were made square, 1x1 ft. in cross-section and 12 ft. long between supports, using $2\frac{1}{2}$x$2\frac{1}{2}$x$\frac{3}{16}$-in. corner angles and 1x1x$\frac{3}{16}$-in. angles for diagonal latticing. Also three latticed I-beams, 12 ft. long between supports, were fabricated with flanges composed of two $2\frac{1}{2}$x$2\frac{1}{2}$x$\frac{3}{16}$-in. angles using 1x1x$\frac{3}{16}$-in. angles for latticing.

The designed load for failure was a concentration of 20,000 lb. at the center of the beams for both types, calculated to produce a maximum cord stress of 29,500 lb., with corresponding stress of 7,050 lb. in the diagonals. The yield points of the six beams indicated by the drop of the beam scale varied from 22,000 to 24,000 lb., with ultimate strength of 24,300 to 25,400 lb., or about 20 to 25 per cent higher than the designed strength. The box beams failed through buckling of the diagonals in compression, and the I-beams, which were supported by clamps at the ends to prevent twisting, failed by the buckling of the angles forming the upper flange. Although all the welding was done by an in-

experienced welder, there was no failure or injury to the welded joints during the test.

Three 1x1-ft. square latticed columns 15 ft. long with legs of $1\frac{1}{2}$x$1\frac{1}{2}$x$\frac{3}{16}$-in. angles and 1x1x$\frac{1}{8}$-in. angles for latticing were arc welded and tested. Based on a factor of safety of 3.5, the ultimate load was designed for 81,500 lb. Limited clearance on the sides of the testing machine was such that bending of the column as a whole would have caused interference before failure. In order to insure failure by localized bending the L/r of the column as a whole was designed less than L/r ratio for the legs between latticing. The ends were placed on spherical seats and the load was applied at a rate of 170 lb. per second.

The yield point in each case occurred at 72,000 lb., and the ultimate loads were 86,150 lb., 76,950 lb. and 89,160 lb. The columns failed by buckling of the legs between latticing, as had been intended in the design, without injury to or failure of the welds.

The strain lines which developed during the testing of the tension and shear specimens were consistent enough to warrant diagrammatic representation shown in the accompanying drawing. These lines of strain began to appear at about one-half the ultimate load, starting at the weld with an inclination of about 45 deg. and increasing as the load was applied. The similarity of stain distribution in tension and cross shear as shown by the strain lines is reflected in an efficiency of 71 per cent for both types of joints. The efficiency of the joints in longitudinal shear where the lines of strain were materially longer was 52 per cent.

A Year's Work in Arbitrating St. Francis Damage Claims

On March 12, the day preceding the first anniversary of the St. Francis disaster, the Los Angeles City Council added, to funds already appropriated, a $2,000,000 funding bond issue, proceeds of which are to be used in paying damage claims approved by the joint committee. This committee was appointed soon after the disaster and now has been at work nearly a year examining and arbitrating claims on the basis announced in *Engineering News-Record,* March 22, 1928, p. 466. Actual payment was delayed by a lawsuit which has now been settled.

A total of 2,828 damage claims of all sorts were filed. About 200 of these have been disallowed by the committee and of the remainder about 90 per cent, representing $3,431,072 in all, have been approved for payment. Many of the largest claims, however, are included in those not yet arbitrated and it is estimated that $7,000,000 may be needed to settle all outstanding claims. This is in addition to the $2,000,000 spent by the city in restoration in the Santa Clara Valley immediately after the disaster.

Claims are divided into three classes: (1) real estate damage, (2) personal property loss and (3) death and personal injury. Under the co-operative plan in effect the city has been able to agree to settlements of most of the real estate damage claims on a basis of about 100 per cent of the amounts claimed. Personal property damages, on the other hand, have been compromised for an average of about 43 per cent of the amount claimed. Death and personal injury claims totaling $5,000,000 were filed. On these settlement has already been effected in cases whose claims totaled $3,000,000, for which the compromise settlements agreed upon total $800,000.

A Railroad Track-Laying Record of 60 Years' Standing

THE SIXTIETH anniversary of "last spike" ceremonies in the first transcontinental railroad, celebrated on May 10 by the Southern Pacific Company, draws attention to a record of ten miles of track laid in 12 hr. which has remained unapproached for 60 years. That record was made after considerable advance preparation, using crews that had several years of training and which were working at the time under the stimulus of great rivalry. The following is from an account recently published by the Southern Pacific Company.

"For some years prior to the completion of the first transcontinental line, construction crews of two companies had been approaching one another. The Central Pacific Railroad was building eastward from Sacramento, Calif., and the Union Pacific was building westward toward a meeting point which was not predetermined; each company was to build as far as it could and would thereafter own and operate the part of the line it had constructed. Both companies were eager to have as much of the transcontinental line as they could, the rivalry extended even to construction crews and became more intense as the meeting point was approached.

"One day the Union Pacific broke all records by laying six miles of track. The Central Pacific bettered this by one mile and under the spur of this defeat, by working from 3 a.m. until almost midnight, the Union Pacific managed to lay $7\frac{1}{2}$ miles of track. Charles Crocker, heading the Central Pacific forces, then announced that he would lay ten miles of track in one day. Trainloads of supplies and hundreds of workmen were organized for the supreme test which came on April 28, 1869. On that day five 16-car trainloads of materials were used.

"One by one these trains were pushed up close to the ever advancing railhead. At a designated point men climbed up on top and threw off fishplates, kegs of bolts and spikes. Stakes were removed from right and left sides of alternate cars to allow the rails to be rolled off. Within 8 min., with a noise like a military bombardment, each train of sixteen cars was cleared.

"Small iron hand-cars were then put on the tracks, each manned by six Chinese under a white boss. Sixteen rails were loaded on each car together with a keg of bolts, a keg of spikes and a bundle of fishplates. Two horses with riders were attached to a car in tandem by a long rope. When the car was loaded and the crew on top, the horses were off on the jump toward railhead.

"One side of the roadbed was kept clear for the horses racing ahead with the material cars. On down grades the horses were detached and the car went flying along with one of the crew acting as brakeman. Meanwhile the horses ran alongside and when a level was reached the nearest rider hooked on again. At the same time empty cars were returning on the single track, all of them at full speed. The crews of an empty car would jump off and lift it from the rails when the loaded car approached, allowing the latter to go past without slackening speed. There was no halt in the continuous stream of materials to the front.

"When the loaded car reached railhead its crew jumped off to give way to a gang with picks who broke open kegs and cut the fastenings of the fishplates. Bolts and fishplates were distributed along the track but spikes were poured out over the rails piled on the car and as

the rails were removed spikes dropped through the floorless car and distributed themselves.

"The rail-laying crew had been recognized in advance as the limiting factor and particular attention was focused on this part of the organization. A picked crew of eight, all Irishmen, did all of the rail laying. These men worked in pairs, four men on each side of the track. When a rail car stopped at railhead, two men seized the forward end of a rail with their tongs while the two others slipped the rear end of the rail to the side of the car so it rested on rollers. The two forward men trotted ahead 30 ft. the length of the rail, and the two behind dropped their end into place where it was bolted and spiked by the track gang. The car was then moved forward half a rail length and the procedure was repeated on the other side. Ahead of the rail layers were men who set the ties to line, and behind came those who spiked, bolted and ballasted, the latter about 400 strong. On the day of the record the eight men in the rail crew each lifted 125 tons of rail.

"The work advanced in the forenoon at the rate of about a mile an hour; six miles of track had been laid when a halt was called for lunch. In the afternoon progress was slower, due to an ascending grade and to curves which involved lost time in bending rails. Bending was done by placing a rail on blocks and striking it with a sledge. By 7 p.m., however, after a little less than 12 hr. of work, a total of 52,856 ft. of track had been laid and ballasted. Jim Campbell, later superintendent of the division, then jumped into a locomotive and ran it back over the new line at 40 m.p.h. just to prove that the job had been well done. It is believed that had the roadbed been perfectly level and straight, the crew on this day could have completed 15 miles of track."

Letters to the Editor

Amount of Smoke No Measure of Carbon Monoxide in Vehicular Tunnels

Sir—*Engineering News-Record* for May 2, 1929, contains an editorial entitled "Carbon Monoxide" in which a statement is made that may be misinterpreted and therefore may be misleading to engineers who are not thoroughly familiar with the subject. After reciting certain experiences on the Oakland Estuary tube, the editorial states:

> "It suggests the possibility that if the Oakland experience is borne out by operation over a longer period and is checked by results elsewhere a new criterion may be adopted for vehicular tube ventilation—that is, CO gaging would become merely a check and the actual basis for determining the rate of air change would be the amount of oil and gas vapors that may be present without offense to keen eyes and sensitive noses."

It is true that smoke and gases irritating to the eyes and nose contained in automobile gases under certain conditions may become offensive during short exposure before the carbon monoxide in the atmosphere causes any ill effect, but the presence of smoke and gases offensive to the eyes and nose depends on so many variable factors that it would be unsafe and uneconomical to use them as a criterion for proper tunnel ventilation.

In my article entitled "A Year's Experience Operating Holland Tunnel," which appeared in *Engineering News-Record* of Dec. 27, 1928, I stated that "it appears probable that the smoke from poorly conditioned automobile engines may become a limiting factor for comfort as soon as or sooner than the carbon monoxide."

It must be borne in mind that the George A. Posey Tube, between Oakland and Alameda, has provision for one line of traffic only in each direction, making the speed of all traffic conform to that of the slowest moving vehicle in each lane. Travel through such a tube would have more frequent stopping and starting and changes of speed than would be the case on a roadway having two lines in the same direction, and it is a fact that under such conditions more smoke is produced than under more uniform speed conditions. An indication that the warning given by smoke and ill smelling gases and smoke is not a safe criterion is shown by the number of deaths in private garages by CO asphyxiation.

After the exhaustive research work which was done in connection with the planning of the Holland Tunnel, as a result of which vehicular tunnel ventilation has been established on a scientific basis, it would be a decided step backward to adopt as a criterion for the proper ventilations "the amount of oil and gas vapors that may be present without offense to keen eyes and sensitive noses" rather than the really dangerous constituent of the gases, carbon monoxide. I cannot believe that *Engineering News-Record* would intentionally advocate such a step. Again it would be extremely difficult to adopt such a standard, as the susceptibility varies greatly with different individuals and it certainly would be impracticable to provide adequate ventilation at a minimum cost without proper means of measuring the carbon monoxide content present in the tunnel atmosphere.

OLE SINGSTAD,
Chief Engineer and Superintendent,
The Holland Tunnel.

New York, N. Y.
May 17, 1929.

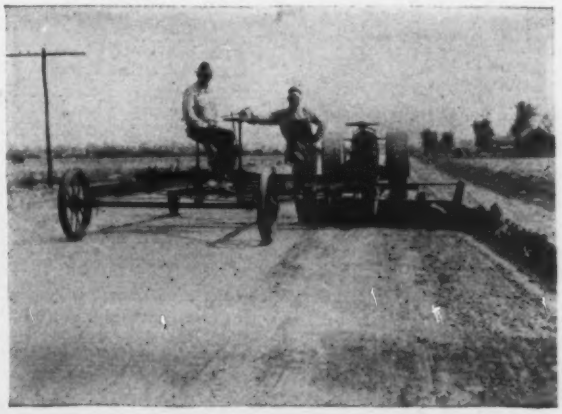
An Effective Shoulder-Building Machine For Highway Construction

Sir—*Engineering News-Record* of April 4, 1929, featuring the subject building with machines and especially the editorial comments lead me to call attention to one detail of hard-surfaced highway construction that until recently had not experienced any change in methods since such work was inaugurated on a large scale some twelve to fifteen years ago.

I refer to methods of building the shoulders or berms of hard surfaced roads. Ever since the advent of modern road-building programs this work has been done largely by hand or by grading equipment not adapted to that purpose. This has been the cause of much unnecessary expense to the contractor and of delays vexations to both contractors and engineers.

Specifications for the construction of shoulders or berms, if interpreted literally, require that they be built as accurately as the pavement itself, and the tendency among engineers in recent years has been to demand more and more accurate work with the result that contractors have been forced to resort to one means or another in the form of special devices to overcome the high costs of building shoulders by a combination of hand work and ordinary grading equipment.

Some contractors still adhere to the original method for



SHOULDER BUILDING MACHINE IN OPERATION

want of something better. Some have devised cumbersome attachments to trucks, tractors or blade machines or a combination of these whereby a certain amount of hand finishing is eliminated. Such devices have succeeded to some extent in reducing costs and producing satisfactory results but they have fallen far short of solving the problem.

Engineers and contractors recently have looked favorably upon the shoulder building device illustrated here. This machine has demonstrated its value in numerous instances and is now extensively employed by the leading contractors in Illinois. It has the advantage of very greatly reducing the cost of operation and of being simple and economical to operate. At the same time it speeds up completion and insures final acceptance and prompt payment.

A. H. HUNTER,
Engineer, Illinois Association of Highway & Municipal Contractors.

Chicago, Ill.,
April 30, 1929.

Competition or Duplication in Railway Service on the Pacific Coast

Sir—In your issue of April 25, 1929, p. 659 appears an article entitled "Competition or Duplication," in which great stress is laid upon Southern Pacific trackage in the Sacramento River Canyon being a "bottle-neck," and in which the implication is given that this is the only Southern Pacific route between San Francisco and Portland. May we not submit the following facts concerning our new line now

NORTH PACIFIC COAST SHOWING NORTH-SOUTH RAILWAYS BETWEEN PORTLAND AND SAN FRANCISCO

under course of construction between Klamath Falls and Alturas which will be ready this fall and which gives us a second route between Los Angeles, San Francisco and the Northwest with very little difference in distances as compared with the proposed Great Northern-Western Pacific route:

Within the last five years Southern Pacific expended over $40,000,000 upon the construction and rehabilitation of 521 miles of mainline track. This investment was based upon a careful traffic study of the regions to be served, and completed plans for development made by Southern Pacific more than twenty years ago. With the completion early this summer of Southern Pacific new mainline bteween Klamath Falls, Ore., and Alturas, Calif., the North Pacific Coast will have a new and shorter mainline to the East and northern California, and southeastern Oregon will have north and south rail facilities adequate for many years to come.

As the proposed Great Northern-Western Pacific line is in all instances considerably longer between points which it proposes to serve than are existing Southern Pacific lines, as it would not develop new traffic but would merely divide traffic with the existing line, and as it would serve no markets not already served via shorter routes, obviously the proposed line would be an unnecessary duplication of Southern Pacific facilities.

The following table indicates the greater mileage of the proposed Great Northern-Western Pacific line as contradistinguished from shorter route over Southern Pacific lines:

BETWEEN THE SAN FRANCISCO BAY REGION AND THE NORTHWEST

	Miles
San Francisco to Portland, via Southern Pacific	721
San Francisco to Portland, via Western Pacific-Great Northern	883
(Via Southern Pacific 162 miles shorter)	
San Francisco to Spokane, via Southern Pacific, Chemult, Great Northern	971
San Francisco to Spokane, via Western Pacific-Great Northern	1,048.7
(Via Southern Pacific 77.7 miles shorter)	
Marysville to Klamath Falls, via Southern Pacific	289.6
Marysville to Klamath Falls, via Western Pacific-Great Northern	298.7
(Via Southern Pacific 9.1 miles shorter)	
San Francisco to Klamath Falls, via Southern Pacific	403.2
San Francisco to Klamath Falls, via Western Pacific-Great Northern	480.9
(Via Southern Pacific 77.7 miles shorter)	

KLAMATH FALLS TO EAST

Klamath Falls to Ogden, via Southern Pacific Alturas Line	786
Klamath Falls to Salt Lake City, via Western Pacific-Great Northern	847
(Via Southern Pacific 61 miles shorter)	
Klamath Falls to Chicago, via Southern Pacific-Union Pacific-Chicago & Northwestern	2,263.
Klamath Falls to Chicago, via Great Northern-Western Pacific-Denver & Rio Grande-Missouri Pacific-Santa Fe	2,549
(Via Southern Pacific 286 miles shorter)	
Klamath Falls to Chicago, via Great Northern-Western Pacific-Denver & Rio Grande-Chicago, Burlington & Quincy	2,611
(Via Southern Pacific 348 miles shorter)	
Klamath Falls to Chicago, via Great Northern-Western Pacific-Denver & Rio Grande-Chicago, Burlington & Quincy via Dotsero Cutoff (not yet built though under consideration)	2,438
(Via Southern Pacific 175 miles shorter)	

Upon completion of Southern Pacific's Alturas-Klamath Falls line to be opened this sumer, it will have in operation a fast first-class mainline east of the coastal mountain ranges. In view of that fact the proposed Great Northern-Western Pacific line would not be of material necessity from a military viewpoint, which it sets up as the chief reason for proposed construction.

In place of a single mainline north and south through the Sacramento canyon, Southern Pacific will have an additional mainline route between Portland, San Francisco and Los Angeles, via Klamath Falls, Alturas and Wendel. In case of a blockade in the Sacramento canyon trains could readily be routed from San Francisco over the "Overland Route" to Fernley and thence north over the new mainline route referred to above.

Southern Pacific's new Portland-San Francisco route through Fernley is 873.1 miles, while the distance over the present and proposed lines of Western Pacific-Great Northern via Sacramento, Keddie, Lookout, Klamath Falls, Chemult, Bend and Wishram is 884.3 miles. Since the new Southern Pacific Alturas-Klamath Falls route would be used between Portland and San Francisco only in emergencies, it would appear that even Southern Pacific's longest way around would be shorter than the route proposed by Great Northern-Western Pacific.

R. E. KELLY,
Manager, Development and Colonization Department, Southern Pacific Company.

San Francisco, Calif.,
May 7, 1929.

News of the Week

Montreal Harbor Improvements Authorized

An additional loan of $10,000,000 to the Montreal Harbor Commission for extension of terminal facilities on Montreal's rapidly expanding waterfront has been authorized by the Canadian House of Commons. This includes $2,000,000 for the construction of three new berths for the unloading of cargo ships; $2,000,000 for the construction of two wharves; $1,500,000 for the extension of the Harbor Commission's electric system beyond Lachine canal; $1,000,000 for increased grain handling facilities, and $500,000 for industrial wharves.

Injunction to Stop New Madrid Spillway Refused

Application for an injunction to stop the award of contracts for the construction of the New Madrid spillway of the Mississippi Flood Control project in Missouri was denied May 22 by Federal Judge Charles B. Davis of St. Louis. The restraining order was sought by a land-owner in the area affected, on the ground that the government in carrying out the spillway plan is seeking to acquire private property without due process of law and without proper compensation.

On May 21 the Missouri legislature adopted a resolution urging President Hoover and Secretary Good to stop the letting of contracts on the grounds that unless the project was halted property values in the district would be irreparably damaged.

As is noted elsewhere in these pages, the Secretary of War has issued orders that no contract shall be awarded pending further investigation of the project.

Oregon Engineering Board Decides to Test Law

The Oregon State Board of Engineering Examiners has ruled that a member of the firm of Carey & Harlan, Tacoma rate engineers employed by the city of Portland to conduct its power rate case against the Portland Electric Power Company, must apply for registration in Oregon and take the examination according to law. Kenneth G. Harlan, member of the firm, who originally took the case, has indicated that his refusal to comply with this edict is final.

The decision of the examining board to test the law followed an opinion from the attorney-general of the state in which the law governing the practice of engineering was interpreted to cover valuation work as well as other branches of the profession. It is said that the legality of Carey & Harlan's $48,000 contract with the city is involved.

Pasadena to Vote on Water Bonds

June 18 has been set as the date for a special election at which the voters of Pasadena, Calif., will be asked to approve a $10,000,000 bond issue for the development of a domestic water supply from the San Gabriel River. If passed, the proceeds of the issue would be used for the construction of the Pine Canyon dam on the San Gabriel River and the building of a conduit 5 ft. in diameter to bring the water to be impounded to the Sunset and Mountain reservoir, a distance of 17.8 miles.

Pennsylvania to Join N. J. in Water Diversion Suit

Permission was granted May 20 by the U. S. Supreme Court to the state of New Jersey to enter suits against the state and city of New York to prevent tapping the upper Delaware in an extension of the New York City water supply, and also to stop pollution of New Jersey beaches by garbage and refuse dumped at sea. It is believed that the state of Pennsylvania and the city of Philadelphia will probably join with New Jersey in fighting for the control and use of the waters of the Delaware River. As noted in *Engineering News-Record*, May 16, 1929, p. 805, New Jer-

RESUME WORK ON OWYHEE DAM AFTER SPRING FLOODS

Two views showing the present status of the Owyhee dam of the U. S. Reclamation Service in Oregon. The illustration on the left, looking upstream at the dam site, shows the mouth of the 22.6-ft. diversion tunnel, now being lined with concrete, and a dragline outfit at work removing rock which has been blasted down from the cliff at the abutment of the dam. On the right is a view looking downstream, showing a piledriver working on the lower cofferdam, which will prevent water discharged from the diversion tunnel from backing up into the dam site. Erection of a 1200-ft. cableway across the canyon is now under way. A travelling tower above the east end of the dam will enable the cableway buckets to reach all parts of the structure. Full details of the proposed dam were given in *Engineering News-Record*, April 26, 1928, p. 603.

sey claims there is no public necessity for the diversion of the tributaries of the Delaware and that most of the water so diverted is to be used for hydro-electric power purposes. It is also stated that the diversion will have a detrimental effect upon the navigation of the Delaware River. Testimony will probably be presented before a special master during the summer, and it is expected that a decision will be handed down some time in the fall.

New York City, in its answer filed with the Supreme Court May 25, requests an extension of 60 days dating from May 27 on the beach pollution case, and at the same time filed a partial answer on the water diversion case, requesting permission to substitute a more complete answer at the expiration of the 60-day period. The partial answer is, to a large extent, a denial of the allegations made by New Jersey that the citizens of that state will be denied of its rights to Delaware water. The city states that it proposes to use only 600 m.g.d. of a total flow of 12,000 m.g.d. (measured at the Delaware state line), storing flood waters from 610 sq. miles of a total of the 2,389 sq. miles of Delaware watershed contained in New York State. Furthermore, it intends to go still further and store additional flood waters for release during periods of low flow at the rate of 0.45 sec.-ft. for each square mile of drainage area above the point of storage. The proposed plan, New York City contends, will modify the flow in the Delaware River in only two particulars: (1) it will cause the flow to be increased and made more uniform during dry seasons, and (2) it will cause flood stages to be slightly reduced. Thus, it is concluded, conditions in the entire valley of the Delaware will be improved as regards navigation, water power, potable quality, fishing and recreation, and industries along the river.

The answer of New York State contains the same denials, and also points out that the state has required the city to make adequate provisions for payment of any damages which may result from execution of the plan.

Wilmington Regional Planning to Be Studied

A regional plan commission for Wilmington, Del., and near-by parts of Newcastle County has been created by a legislative act recently approved by the Governor. The commission will consist of five unpaid members, to be appointed by the Governor. As the act now stands, the commission is to serve only until the session of the Delaware Legislature, to which it will report its findings as to "the desirability of establishing a regional plan for Wilmington and vicinity in order to secure an orderly development of highway and other means of communication, sanitation, utilities and other improvements necessary for the satisfactory development of a modern urban and suburban community."

Illinois Considering Transfer of Waterway to Federal Government

With State Bond Issue Exhausted and No More Funds Available, Completion by U. S. Is Proposed

AFTER nine years of leisurely construction progress, hindered by political and other influences, the 63-mile Illinois waterway to link the Chicago drainage canal with the Illinois River again faces serious delay due to financial difficulties, which may result in its transfer to the federal government.

Years of talk and promotion for this link in a navigable route from the Great Lakes to the Gulf culminated in 1903 with a public vote in favor of a bond issue of $20,000,000 for the work. The first plan was for 14 ft. of water, with provision for 24 ft. in the future. A later plan, in 1915, was for 8 ft. of water, but the U. S. War Department refused to grant a permit for the work in the Illinois River. A bill for a waterway was signed by the governor of Illinois in July, 1919, and approved by the U. S. Government in February, 1920. The first contract was let in 1920. This bill, covering the present project, called for a 9 ft. depth of water, but with 14 ft. of water on the sills of the five locks, 110x600 ft. It was estimated that the cost would come within the $20,000,000 authorized and that the waterway could be completed in 1930.

But at the end of 1928 the entire amount had been spent or allotted to work already undertaken, while the project was far from completion. Of the five dams and locks, two were finished, one was under construction by contract and a fourth was being built by State forces, using equipment leased from a contractor, who thus acted as a superintendent of construction. Besides these major works, much minor or subsidiary work is still to be done before the waterway can be put in operation. More money is needed, probably about $5,000,000. The State's constitution prohibits appropriations for canals, while a new bond issue cannot be submitted to vote for about two years. In this dilemma it has been proposed to seek the aid of the War Department or of Congress, the former to carry out the work as a federal project and the latter to appropriate the necessary funds in the River and Harbor bill.

Limit Set to Diversion of Connecticut River Water

A recent ruling of the War Department sets a limit on the amount of water which may be diverted from the Connecticut River water shed for use by the Boston metropolitan water district. It has been claimed by the state of Connecticut that such diversion would interfere with navigation on the lower section of the river. The ruling, which is qualified to permit future revision, states that there will be no substantial alteration of the navigable capacity of the channel if the measured rate of discharge of the Swift River, a tributary of the Connecticut, shall be maintained at 70 sec.-ft. on such days as the discharge at Sunderland is between 4,000 and 4,650 sec.-ft. and 110 sec.-ft. when the Connecticut River discharge at the same point is less than 4,650 sec.-ft.

St. Louis Refuses to Accept Bartholomew Resignation

A special committee of the St. Louis, Mo., City Plan Commission which had been appointed to consider the tendered resignation of Harland Bartholomew as engineer for the commission has recommended that the Commission refuse to accept the resignation.

In rejecting the resignation the committee suggests that a conference be held with the proper city officials in an effort to eliminate some of the present difficulties by obtaining an increase in salary for Mr. Bartholomew, who is paid but $4,000 annually. An effort will be made to have the city raise this salary to a point that will enable Mr. Bartholomew to continue to serve St. Louis.

A.S.T.M. Announces Program for Annual Meeting

Announcement has been made by the American Society for Testing Materials of the preliminary program for the 32nd annual meeting to be held at Atlantic City, N. J., June 24-28, 1929. Listed on the program are the reports of 50 committees, including the research committees on fatigue of metals and yield point of structural steel; the sectional committee on specifications for cast-iron pipe; and the committees on cement, brick, clay and cement-concrete pipe, and concrete and concrete aggregates. There will also be reports of committees on preservative coatings for structural materials, road and paving materials, timber, and bituminous waterproofing and roofing materials.

The program also lists for presentation 38 papers, including the following of special interest to civil engineers: "Fatigue Tests on Specimens of Large Diameter with Special Reference to Welds," by R. E. Peterson; "A Compression Test for Portland Cement," by O. L. Moore; "Effect of Certain Powdered Admixtures in Concrete," by D. A. Abrams; "The Effect of Age and Other Factors Upon the Modulus of Elasticity and Poisson's Ratio of Concrete," by R. E. Davis; "The Water Absorption and Penetrability of Brick," by J. W. McBurney; and "Elastic Calking Compounds for Weatherproofing Masonry," by H. H. Dutton.

Other features of the program are the annual presidential address by G. W. Thompson, the Edgar Marburg Lecture by Saul Dushman, assistant director of the research laboratory of the General Electric Company, and the award of the Charles B. Dudley Medal to J. J. Kanter and L. W. Spring.

LOOKING DOWNSTREAM ON REMAINS OF DAM

Balsams Dam Failure Caused by Erosion of Rip-Rap

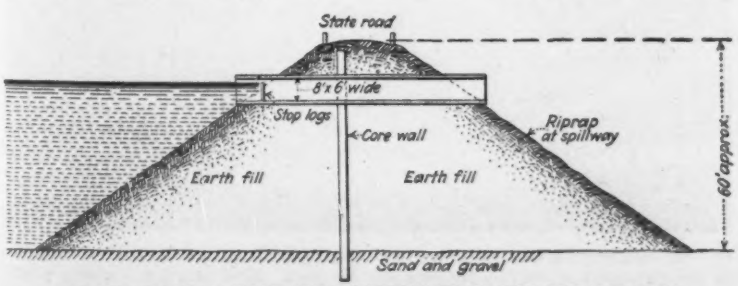
The destruction on May 3 of Balsams dam, an earth dam at the head of the Mohawk River in New Hampshire, as reported in *Engineering News-Record*, May 9, 1929, p. 770, was caused by failure of a coat of rip-rap to protect the downstream slope of the dam from erosion by water discharged through the spillway. Although this erosion had been going on for some time, it is stated that the immediate cause of the failure was the unusual amount of water passing through the spillway due to several days of heavy rain. It is also reported that there was a small leak through the bottom section of the dam, but as this had continued for years without perceptible increase, it is thought to have had no relation to the failure.

Balsams dam was of earth construction with a concrete core wall, and was surmounted by a state highway crossing the valley. It was built by the Dixville Notch Corporation primarily to provide fishing for guests at a hotel owned by the corporation. The approximate dimensions of the dam were: Length, 300 ft.; maximum height, 60 ft. Excess water passed through a box culvert spillway 8x6 ft. in cross-section which discharged its contents high on the downstream face. Apparently the builders depended upon a paving of rip-rap to prevent the washing away of material at the toe of the dam. Eye-witnesses of the failure state that this rip-rap washed completely away and that the earth fill soon followed. The spillway, lacking support, dropped apart of its own weight, and complete failure of the dam resulted.

The lake formed by the dam had a drainage area of only 2 or 3 square miles in steep mountainous country. The New Hampshire Public Service Commission states that during the flood of November, 1927, the discharge of this stream at a point 3 miles below the dam was 4,340 sec.ft., or approximately 167 sec.ft. per square mile from a drainage area of 26 square miles. At that time the lake was only partly filled, and the dam apparently sustained no damage from the floods.

CROSS-SECTION TAKEN FROM STREAM BED, SHOWING CORE WALL AND EARTH BANK

Failure of the dam resulted in the complete destruction of the village of Kidderville, with a population of 50, and also did some damage in Colbrook, N. H. No lives were lost as ample warning had been received. Late reports, however, state that seven bridges and about twenty buildings were completely destroyed. Considerable damage was also done to a state highway which paralleled the Mohawk River below the dam.



CROSS-SECTION SHOWING CONSTRUCTION OF BALSAMS DAM

I.C.C. Authorizes Construction of Two New Rail Lines

Recent decisions of the Interstate Commerce Commission have authorized the construction of two new lines of railroad. The first of these will connect San Angelo and Sonora, Texas, a distance of approximately 65 miles at a cost of $2,200,000. The road will be built during 1930 by the Kansas City, Mexico & Orient Railway Company of Texas. The second line will be built by the Owensboro-Rockport Bridge Company, to connect Owensboro, Ky., and Rockport, Ind., approximately 12 miles, by a railroad and bridge across the Ohio River. The estimated cost is $5,203,275, including $3,454,000 allotted to bridge construction. The line is to be completed by December 31, 1931.

Inspect Manufacture of Hudson River Bridge Cables

An unusual opportunity to view the extensive processes incident to the manufacture of the cable wire for the Fort Lee-Hudson River Bridge in New York City was accorded some 300 engineers and guests on May 2 when the John A. Roebling's Sons Company, for the first time in its history of over 80 years, opened the gates of its Trenton, N. J. plant to an inspection party of an organized society, in this case the New York Electrical Society.

For testing the cables the John A. Roebling's Sons Company purchased a specially built universal testing machine which ranks as the world's largest, having a capacity of 2,000,000 lb. The machine weighs 270,000 lb. and stands 43 ft. high. A special test of a suspender rope for the bridge was carried out for the visitors. The rope, $2\frac{7}{8}$ in. in diameter, of 6x37 construction, having a 7x7 independent wire rope center, broke at a load of 1,363,000 lb. Briefly, the process of bridge wire manufacture from the open hearth furnaces to the finished wire follows in order: Ingots poured from acid open hearth furnaces; 2x2 in. bars rolled from ingots and air cooled; reheated in a producer-gas oven and hot drawn into rods $\frac{3}{8}$ in. in diameter which are coiled and finally cooled in water-jacketed tunnels; coils pickled and dipped in lime solution; wire drawn cold through dies of reducing size from the $\frac{3}{8}$ in. rod down to a wire 0.192 sq.in. in area. Depending on conditions the wire is pickled and annealed several times between the first and last cold drawing. The final operation consists of galvanizing and coiling.

A new bridge shop has been erected

in connection with the work on the Hudson River bridge cables. In this shop the coils of wire as manufactured will be wound on structural steel spools about 8 ft. in diameter, each spool containing 40 connected coils each 4,000 ft. long. Thus each spool as it will be shipped to the bridge site will contain sixteen thousand pounds of wire having a length of 160,000 ft. The coils are spliced with a threaded sleeve subsequently battered in a hydraulic press so that the resulting splice develops 95 per cent efficiency. The amount of wire stock under the roof of the bridge shop at the present time is about 30,000,000 lb. or one-half of the bridge requirements.

Los Angeles to Vote on Bond Issue of $40,000,000

The Los Angeles City Council has voted to submit to the voters at the general city election on June 4 two bond issues aggregating $40,000,000 for the purpose of municipal water and electric construction. This action of the city council definitely approves the three-year program presented by the Water and Power Department of the city. The power bond issue will amount to $17,500,000 and the water bonds to $22,500,000.

Among the major projects to be financed by the $22,500,000 water bonds are: Purchase of water lands and water rights in Owens River Valley not already owned by the city, thereby increasing the aqueduct water supply appromimately 25 per cent; construction of additional reservoir capacity near Los Angeles, sufficient to store 12,000,000,000 gal. of water for domestic use; installation of 150 miles of 36 and 24-in. trunk lines to deliver large quantities of water to widely separated sections of the city.

Among the major projects to be financed by the $17,500,000 power bonds are: Erection of two new hydro-electric generating plans in the Owens River Valley, water to operate these plants to be made available by the proposed water land purchases; construction of 200 miles of high-voltage transmission power lines to carry the power from Owens River Valley to Los Angeles; installation of 1,100 miles of power and light distributing lines and underground cables; and erection of six new electric distributing stations.

Work to Start on Water System for Everett, Wash.

Following the passage of a $2,000,000 bond issue, bids will be called within the next ninety days on the municipal water system project for the city of Everett, Wash. Work includes construction of a conversion dam at the intake on the Sultan River, a storage dam on Lake Chaplain, 20 miles of pipe line, and two tunnels with a total length of 11,000 ft. When completed the new system will have a capacity of 50 m.g.d. Either steel or concrete pipe 52 in. in diameter will be used.

Baltimore Names Committees to Report on City Problems

Two committees of citizens have been named by the city of Baltimore, Md., to advise the municipal authorities. One will determine the "current wage scale" to be paid men employed on municipal work. Recently a strike of short duration was called on the $7,500,000 terminal project for the Western Maryland Railway Company, which the city is now building. The strike was settled when the city agreed to pay its employees the "current wage" in Baltimore. This will be determined by a committee consisting of Jacob H. Hollander, professor of political economy at Johns Hopkins University; M. A. Long and B. Frank Bennett, contractors; Ralph C. Hudson, of the Baltimore Association of Commerce, and Edward D. Bieretz, executive secretary of the Building Trades Council.

Various plans advanced for the extension of Howard Street and the construction of an east-west viaduct, as proposed by Charles F. Goob, chief engineer of the city, will be reviewed by another committee composed of J. E. Greiner, engineer of the Port Development Commission; Henry Adams, consulting engineer, and Clyde N. Friz, architect.

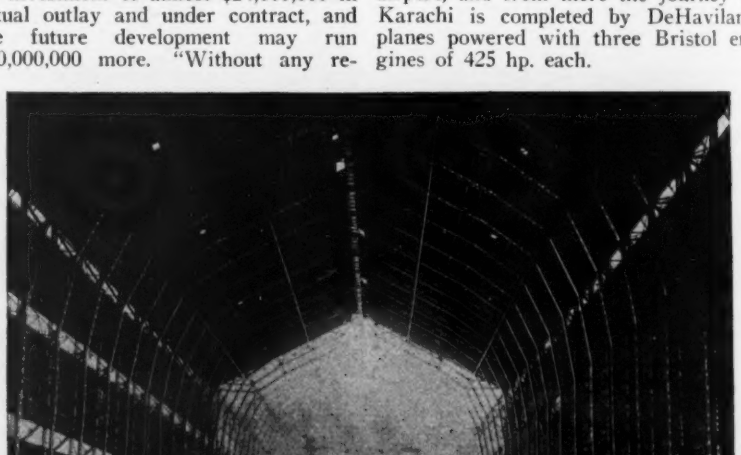
Expert Advice on Skagit Project Recommended by Citizens

An expert commission to advise the Seattle city council, the light department, and the city engineering corps on the development of the Skagit power plant is recommended by a special investigating committee which reported to the Municipal League recently. The report calls attention to the fact that the Skagit development now represents an investment of almost $24,000,000 in actual outlay and under contract, and the future development may run $50,000,000 more. "Without any reflection on the personnel of the light department or the engineering department, it is believed that these departments would be strengthened and made more effective by the employment of an engineering commission to develop policies and further development of the Skagit project and to advise the council of the economic phases of that development, including the cost of production and prospective need of power," the report reads.

London-India Airway in Active Operation

The new airway from London to India has been in active operation for several weeks. At the terminus of the airway at Karachi there has recently been completed a huge airship shed which until the completion of the Goodyear-Zeppelin airship factory and dock at the Akron municipal airport will rank as the world's largest airship hangar. A view of the Karachi shed under construction is shown herewith.

There are three distinct stages on the London-India airway, each operated by a separate type of airplane. The first stage, from London to Basel, is operated by three-engined biplanes equipped with Armstrong-Siddleley air-cooled engines of 395 hp. having a cruising speed of 95 m.p.h. From Basel the passengers proceed during the night by railroad sleeping car to Genoa, where the second part of the journey commences. Here large metal flying boats powered by three Bristol geared air-cooled engines of 485 hp. each fly to Alexandria Harbor. These flying boats have seats for fifteen passengers in addition to the pilot, engineer, wireless operator and steward. . The cruising speed is 95 m.p.h. From Alexandria Harbor the passengers are taken by car to Aboukir airport, and from there the journey to Karachi is completed by DeHaviland planes powered with three Bristol engines of 425 hp. each.



INTERIOR OF PARTLY COMPLETED AIRSHIP SHED AT KARACHI, INDIA
In the distance the erection traveler may be seen. Roof plates are shown piled in the foreground.

WASHINGTON NOTES

By Paul Wooton
Washington Correspondent

Can Flood Control Plans Be Reconsidered?—Permit Asked for Fundy Tidal Power Project

IN ANNOUNCING that he had asked the Attorney General and the Secretary of War to report upon the legal questions involved in the interpretation of the flood control act, President Hoover issued a statement to which unusual significance is being attached. The opinion is expressed by some that the President must have some reason to think there is merit in the recommendations of American Engineering Council and of a committee of Senators and Representatives from the Mississippi Valley, since he has intervened in the matter. Otherwise, it is contended, he would have been satisfied to allow the Army Engineers to continue to carry forward the flood control program in their own way.

The American Engineering Council and the committee of legislators each has recommended that the study of the engineering plans be reopened. The President in his statement points out that it is possible that the executive order of President Coolidge promulgating the findings of the board of review, headed by General Jadwin, may be conclusive under the terms of the act. The fact that an executive order had been issued in connection with this report had not been known previously. President Coolidge announced, however, that he had not approved that portion of the report which deals with compensation for property. In view of the fact that the report had not been approved in its entirety the congressional committee took the position that it could be reopened and studied anew. That committee interpreted the act to convey continuing authority upon the President to study the differences in the engineering plans. Apparently President Hoover is in doubt as to that point and has called for the opinions of the Attorney General and the Judge Advocate General.

The issuance of the statement also has given rise to the assumption that the Secretary of War was acting under orders from the President in announcing that no awards of contract would be made in the Birds Point floodway, pending a study of the matter.

The congressional committee is particularly anxious to have it understood that they are entirely satisfied with the portions of the flood control program which are under way, that is, the construction of the Bonnet Carre spillway, the strengthening of the levees and the revetment of the banks. The full text of the President's statement follows:

A group of Senators and Representatives interested in the Mississippi flood control have placed before the administration a brief requesting that the proposed contracts for initiation of works should be suspended pending entire reconsideration of the plans and authorities under the flood control act. Some of them contend that the entire flood control plan should be revised; that, in fact, the conflicts between the Mississippi River Commission plan, estimated to cost some $750,000,000, and the Jadwin plan, estimated to cost about $325,000,000, should be reconsidered.

The act provided that a special engineering board should be set up to make the determination as between these plans and to report their conclusions to the President. This was done. The report recommended the Jadwin plan, and President Coolidge promulgated it by a definite order.

The effect of other suggestions is that the government should purchase flowage rights over lands along stretches of the river where there is to be no additional water flow out of the main channel. Where the United States is required by the law to purchase land, or flowage, or pay damages, this will be done in any event. Moneys have been scheduled for such payments out of funds so far appropriated.

Before the merits or demerits of the subject can be gone into, I must first determine the legal questions involved as to whether or not the plan and method have not already been conclusively determined by the flood control act and the executive decisions of President Coolidge. I have submitted the questions to the Secretary of War and the Attorney General for study and report.

Hudson Bridge May Be Approved

That the forthcoming report on the application to bridge the Hudson River at 57th St., New York City, is not altogether unfavorable is indicated in an oral statement made May 27 by the Secretary of War.

Tidal Power

Dexter L. Cooper, Inc., has applied to the Federal Power Commission for a license covering a proposed tidal power development at Passamaquoddy Bay. The plan calls for the immediate installation of 464,000 hp. and the ultimate installation of 1,087,000 hp. The project contemplates the construction of a series of dams connecting the mainland with islands across the mouth of Passamaquoddy Bay to impound tidal waters within that bay. Another series of dams is to be constructed between Passamaquoddy Bay and Cobscook Bay. The power house is to be erected at that point. In addition there will be a series of dams across the mouth of Cobscook Bay to exclude tidal waters. The plans provide for the installation of suitable gates for the passage of tidal and tail race waters. There will be a navigation lock connecting the open ocean with Passamaquoddy Bay. Another lock will be located in Cobscook Bay.

A recently adopted feature of the project is a plan to pump water from Haycock Harbor into a reservoir to be constructed on the mainland at an elevation of 140 feet above sea level. Water will be pumped into this reservoir at such times that excess power is available and drawn down when tidal power is at its minimum. To furnish the necessary power for pumping it is proposed to install five 41,000 hp. units. By making available this power it is expected that many steam plants in Maine, in northeastern Massachusetts and in New Brunswick can be eliminated. Mr. Cooper estimates the cost of the project at $93,000,000. The War Department's district engineer has reported favorably on the project, although he is of the opinion that the project will cost $100,000,000 and that it will require seven years to construct. Mr. Cooper estimates that the construction can be done in three years.

Rights granted by the province of New Brunswick have expired. The government there has refused a request to renew them for two years. There is reason to believe, however, that the necessary permit will be issued by the New Brunswick government when definite plans have been made.

A preliminary study made on behalf of the fish industry has resulted in a report stating that the development would eliminate herring from Passamaquoddy Bay but that a further study will have to be made to determine the effect on fish outside of the bay. Herring are attracted in great numbers to this particular spot. The reason for this has not been established. It will be necessary for the applicant to take the necessary precaution to protect the interests of the fish industry, but it is believed that that problem can be worked out.

Gifts for Research Announced by Engineering Foundation

At the tri-annual meeting of the Engineering Foundation held in New York City May 23 it was announced that $720,000 of its proposed endowment fund of $5,000,000 has been raised, and that the foundation has been promised a number of future gifts ranging from $20,000 to $500,000 through legacies, annuities and trusts. It was also announced that the Society of Naval Architects and Marine Engineers had decided to combine its funds annually available for research with those of the Engineering Foundation in the interest of more effective use. Two additional gifts have been made to aid a research project in iron and steel alloys which is to be undertaken. One was $50,000 from the Battelle Memorial Institute of Columbus, Ohio, to be spent at the rate of $10,000 a year for five years. The other was from the United States Bureau of Standards, which will allocate the services of its research staff to the amount of $1,000 a year for the same period. This investigation will consist of a critical review of all available literature on iron and steel alloys, and also research directed toward increasing fundamental knowledge.

At this meeting H. Hobart Porter, the new chairman of the foundation, was inducted into office by Lewis B. Stilwell, the retiring chairman. The principal speaker was Harvey N. Davis, president of the Stevens Institute of Technology, who reported on the results of research in the properties of steam.

It was also announced that James H. McGraw, chairman of the Board of the McGraw-Hill Publishing Company, had contributed $50,000 to the Engineering Societies Library, increasing the amount raised for this purpose thus far to $200,000.

Engineering Societies

CALENDAR

ANNUAL MEETINGS

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; annual meeting, Atlantic City, N. J., June 24-28.

AMERICAN WATER WORKS ASSOCIATION, New York; annual meeting, Toronto, Canada, June 24-28.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; annual convention, Milwaukee, Wis., July 10-12.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; annual meeting, Mexico City, Aug. 26-28.

Personal Notes

Col. AMOS A. FRIES, until recently Chief of the Chemical Warfare Service, U. S. Army, was retired on May 15 at his own request after more than 34 years of service. He retires with the rank of Major General. During the war General Fries served with the U. S. Engineers as colonel and brigadier general and was responsible for the organization of the gas service.

JACOB C. KRUM, of Toronto, Ont., formerly on the staff of the Ontario Hydro-Electric Power Commission, has been appointed chief designer for the Northwestern Power Company in connection with the Seven Sisters Falls power development in Manitoba.

GEORGE W. MCCORDIC, RALPH A. STADLER and GEORGE A. LARSON have organized the engineering firm of McCordic, Stadler and Larson, Detroit, Mich. All three have been employed during the past seven years by Hubbell, Hartgering and Roth, of Detroit. The new firm will specialize in sewerage, sewage disposal, drainage, water supply, paving and other municipal work.

GERALD J. WAGNER, formerly consulting engineer for the City of Grand Rapids, Mich, has resigned to go into private engineering practice.

G. H. T. SHAW, La Salle, Ill., has been appointed principal assistant to the division engineer on that part of the Illinois Waterway between Joliet and the Starved Rock dam and lock, with headquarters at Marseilles, Ill. Mr. Shaw had been engaged for some years on railway and other engineering works in Mexico.

W. H. PINKHAM, formerly engineer of sewers under the Los Angeles, Calif., city engineer, has been transferred to the position of assistant engineer in the Department of Water and Power. The transfer marks the termination of eighteen years of continuous service by Mr. Pinkham in the Department of Public Works.

PERRY C. CRAWFORD, vice-president and general manager of the California-Oregon Power company, has resigned to become president of the American Utilities Service Co., a recently organized company with headquarters in Chicago. He will be succeeded by CHAUNCY M. BREWER, vice-president and general manager of the Mountain States Power Company, who will also retain his present office.

DON A. TOLBERT, of Denver, Colo., has been appointed town engineer of Asher, Okla., which is planning water and sewer extensions in the near future.

A. L. KROEGER has been appointed engineer in charge of the installation of new work at the Durango, Colo., water system. The estimated cost of the work is $300,000.

C. R. HORAN, who has been stationed at the United States Naval Base, Guantanamo Bay, Cuba, will supervise government construction work in Nevada.

Obituary

ARTHUR WELLS ROBINSON of Upper Melbourne, Quebec, died in Montreal May 23 in his 69th year. He was born at Collingwood, Ont. and came to Montreal in 1877, where he was engaged in work on the Montreal Harbor and the St. Lawrence River ship canal. In 1885 he became designer and managing engineer for the Bucyrus Company of South Milwaukee, Wis., where he aided in the development of the American type of steam shovel, and designed the first large shovel for mining iron ore. Returning to Canada in 1900, Mr. Robinson was engaged as consulting engineer by the Canadian Department of Public Works, and also served in that capacity for the Egyptian Government, and in connection with various harbor works in China and India. He designed and built more than 400 dredging machines of various types and developed the Robinson rotary cutter for hydraulic dredges and stiff clay soils. A Canadian government dredge designed by him and fitted with a cutter of this type made a world's record for output. He was a member of the Institute of Civil Engineers of London, the American Society of Mechanical Engineers, the American Society of Civil Engineers and the Engineering Institute of Canada.

CAREY VANDERVORT HODGSON, assistant chief of the geodesy division, U. S. Coast and Geodetic Survey, was drowned May 19 when caught in a canoe by a sudden storm about a mile offshore from Bay Ridge, Md. His body was not recovered until May 22. At the time he was accompanied by his ten-year-old son, who was also lost. Mr. Hodgson graduated from Haverford College in 1903, and immediately entered the U. S. Coast and Geodetic Survey, in which he served throughout his life except for a brief interval of war service with the U. S. Engineers. During his career with the Coast and Geodetic Survey, Mr. Hodgson took part in topographic and land surveys in Maine, Alaska, the Philippines and various parts of the United States. In 1917 he entered the army as a captain, being advanced to the rank of major some time later. He was for a time in command of Company B and the second batallion of 104th Engineers, and also served as topographical engineer and assistant division engineer for the 20th Division. He was a member of the American Society of Civil Engineers, a fellow of the American Association for the Advancement of Science, and the author of several books on surveying.

JOHN DUNCAN MACVICAR, district engineer of municipal roads for Toronto, Ont., was instantly killed May 14 when an automobile he was driving was struck by a Canadian National Electric Railway car. Mr. MacVicar started his engineering career with the Canadian Pacific Railway in 1894, being engaged on surveys for nine years. In 1903 he was employed by the Grand Trunk Pacific, later being advanced to the post of locating engineer. He left this line in 1905 to become associated successively with the Northern Pacific Railway, the Portland & Seattle Railway and finally, in 1906, the Chicago, Milwaukee & St. Paul. Here he was district engineer in charge of the construction of 35 miles of road to Hellgate Canyon, later being transferred to the Missoula division, where he was advanced to assistant engineer of the construction division.

CLIFFORD LYNDE, aged 44, died May 21 at Walden, N. Y. He was a graduate of Massachusetts Institute of Technology, 1906, spending his summers in miscellaneous surveys in the vicinity of Boston. After graduation he spent one year as rodman for the Pennsylvania Railroad and then entered the employ of the New York City Board of Water Supply on the construction of the Catskill aqueduct. During his seven years on this work he aided in designing, surveying and construction for various portions of the aqueduct, especially in shaft and tunnel construction on the Roundout siphon on the Esopus Division. In 1914 Mr. Lynde became assistant engineer for the Cranford Company, contractors on the Brooklyn subways. He also spent five years in Florida before and during the recent boom. He was an associate member of the American Society of Civil Engineers.

Col. WILDS PRESTON RICHARDSON, U. S. Army, retired, died May 20 at Walter Reed Hospital, Washington, D. C., at the age of 69. He was a graduate of the U. S. Military Academy at West Point, class of 1884, and during the World War commanded the American Expeditionary Forces in North Russia, for which he received the Distinguished Service Medal. Colonel Richardson was for many years engaged in construction work in Alaska, and was the builder of the Richardson Trail from Fairbanks, at the head of the government railway, across the interior of Alaska to the copper mining district.

Construction Equipment and Materials

Bureau of Standards to Test Pipe Coating

A general study of the nature and method of application of the more common types of protective pipe coating is now being conducted by the American Gas Association in co-operation with the U. S. Bureau of Standards. As soon as this is completed, a number of manufacturers will be asked to apply their products to pipe samples, which will be buried in several locations where the corrosion is known to be severe. After a suitable interval samples will be removed for examination as to the protective qualities of the coatings. The Bureau of Standards states that manufacturers of coating who wish to be included in the test should communicate with it as soon as possible.

Publish Data on Steel Erection

A fact book for the steel construction industry has been prepared by the American Institute of Steel Construction, Inc., 285 Madison Ave., New York City. Some 22,000 words used by structural steel engineers are defined in the book. The new volume also includes a directory of fabricating shops in the United States, Canada, Mexico and Hawaii and presents a statistical outline of the progress of steel construction. It will also contain a list of technical publications on structural steel and numerous illustrations.

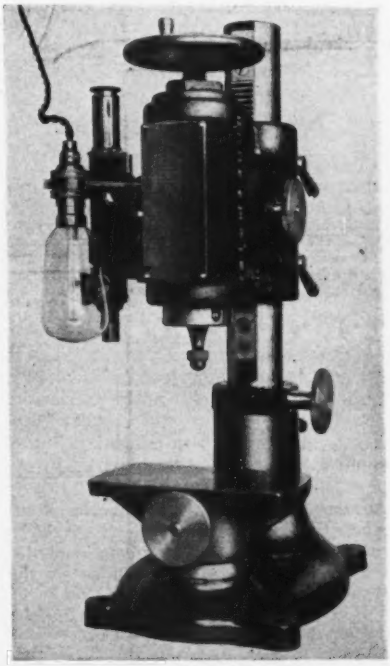
New Developments

Hardness Testing Machine Developed in England

A patented testing apparatus known as "The Hardometer" designed for determining the hardness of metals has been placed on the English market by Messrs. Thomas Firth & Sons, Ltd., Sheffield, England. The principle embodied in the machine is similar to that of the Brinell hardness machine in which a hard steel ball is pressed by means of a known load into the specimen to be tested, the hardness being determined by measurement of the impression. It is said that the hardened steel ball is not efficient in the harder range of metals and that a pyramidal Diamond indenter may be supplied with the machine for this purpose. The hardness numbers are obtained by dividing the load in kilograms by the area of the impression in square milimeters and this rule applies both in regard to the steel ball and the Diamond indenter. The values obtained, however, are known as Brinell hardness numbers and Diamond hardness numbers, respectively.

The microscopic principle of measurement is used on the machine as is also a spring load in place of the lever applied load. It is claimed that the low stresses assure that discrepancies will not occur.

The machine will test the hardness of medium and hard steels down to 1 mm. thick and soft steels and non-



ferrous metals down to 2 mm. thick when using a standard 120 kg. load cylinder and a 1-in. microscope objective. When using a 30-kg. load and a ½-in. microscope objective ½-in. mm. thick of a hard steel and 1 mm. for the soft steel and non-ferrous metal are possible. The maximum space between the anvil and the head is 8 in., unless specially specified otherwise.

Railroad Inspection Car Follows Locomotive Design

A new development in railway motor cars is found in the specially built automobile-type inspection cars furnished to the Santa Fe Railroad by the Buda Company, Harvey, Ill. The car is powered by 114 hp. 6 cylinder Buda engine. The interior is completely fitted with control board, dome lights, curtains and heater. The seating arrangement provides for twelve passengers with the rear seat reversed for track inspection—the rear glass being full width of the car. Three of these cars have been furnished

the Santa Fe Railroad, the first of which ran from Chicago to Topeka, Kansas, a total of 534 miles on its own power and under train orders, averaging 7½ miles per gallon of gasoline. From Kansas City to Topeka the car averaged approximately 45 m.p.h. running time. One of the other cars in service near LaJunta, Colo. was driven over exceptionally difficult track with 3 per cent grades and many curves of from 3 to 11 degrees, maintaining a speed of 30 m.p.h.

A special feature is the use of rubber inserts in the wheels. These are built with rolled steel rims and cast steel centers, special live rubber inserts being placed between. This is claimed to keep practically all of the mechanical noises away from the car body. A special copper shoe arrangement sliding on the top of the rail assures proper operation of the automatic signals. In case the wheels are derailed the car will not leave the track but slide along the top of the rail on the structural steel underframe.

Interlocking Metal Plates for Highway Grade Crossing

A highway grade crossing composed of interlocked metal plates mounted on rubber cushions known as Bull Frog unit paving has been placed on the market by the Indianapolis Switch & Frog Company, Springfield, Ohio. The interlocking plates are made in standard lengths of 20 in. and in two standard widths, those between the rails of the track being approximately 28 in. wide and those outside of the rail 20 in. wide. As shown in the accompanying sectional view each plate is anchored to the base of the track rail by jaws which are protected from direct contact with the metal by heavy blocks of rubber. These blocks provide insulation, prevent wear or breakage of the jaws and absorb shocks from loads passing over the crossing. They are also claimed to reduce noise. Plates are supported at their free ends by second-hand rails, one of these rails being placed in the center of the track and one at each side.

Business Notes

PULASKI FOUNDRY & MANUFACTURING CORPORATION, has its main office and works at Pulaski, Va., rather than at Pulaski, Vermont, as stated in our May 2 issue.

J. D. WALLACE & COMPANY, Chicago, Ill., manufacturer of portable woodworking machinery, has taken over the John T. Towsley Manufacturing Company of Cincinnati, which will continue to operate under its own name as a division of the Wallace company.

WAGNER ELECTRIC CORPORATION, St. Louis, Mo., announces the appointment of L. G. Tandberg as branch manager of its Los Angeles sales office.

WOOD CONVERSION COMPANY, Cloquet, Minn., announces the appointment of H. E. Peterson as sales manager. Mr. Peterson since 1912 has been connected with the Beaver Products Company.

TIMKEN ROLLER BEARING COMPANY, Canton, Ohio, at a meeting of the board of directors May 7 elected Martin T. Lothrop president of the company, succeeding H. H. Timken, who becomes chairman of the board.

SPEEDER MACHINERY CORPORATION, Cedar Rapids, Iowa announces the appointment of H. W. Parsons as assistant general sales manager. Mr. Parsons was formerly district sales engineer in the Pacific Northwest territory, and will be succeeded in this position by B. C. Larrabee, with headquarters at Portland, Ore.

ASH GROVE LIME & PORTLAND CEMENT COMPANY, Omaha, Nebr., announces that its new plant at Louisville, Nebraska, only a few miles from Omaha, near the Iowa-Nebraska state line, is in operation.

CHICAGO PUMP COMPANY, Chicago, Ill., has added P. S. Lord to its sales staff, with offices at Portland, Ore.

GENERAL EXCAVATOR COMPANY, Marion, Ohio, has opened a new branch office in Atlanta, Ga., under the name of the General Excavator Sales Company. P. L. Tippett is district manager.

ORTON CRANE & SHOVEL COMPANY, Chicago, Ill., announces the appointment of Mott & McElrath Engineering Corporation, 249 West 18th St., New York City, as its Metropolitan district representative.

ROBBINS & MYERS, INC., Springfield, Ohio, announce a complete new line of electric and hand power cranes, hoists and trolleys up to 10 ton capacity, this new equipment being manufactured in a new division of the company in which the executive, technical and sales personnel were all formerly associated with the Chisholm-Moore Manufacturing Company of Cleveland. Frank F. Seaman is general manager, Carl E. Schirmer chief engineer and John R. Mears is sales manager. Albert Kreh, William J. Scott and John J. Becker are district sales managers for New York, Chicago and Detroit, respectively.

GARFIELD FIRE CLAY COMPANY, Bolivar, Pa., has placed H. I. Robinson and D. J. Matheson in charge of its Eastern sales office in Philadelphia. Mr. Matheson was formerly in charge of sales in the Philadelphia district for the Queens Run Refractories Corporation.

JEFFREY MANUFACTURING COMPANY, Columbus, Ohio, announces the incorporation of the Jeffrey Manufacturing Company, Ltd., at Montreal, Que. A branch office is maintained in Toronto and a mining supply warehouse in Calgary, Alberta. The officers of the Jeffrey Manufacturing Company, Ltd., are R. W. Gillispie, president; R. H. Ross, treasurer and manager, and F. N. Diehl, secretary.

New Publications

Chlorinizing Apparatus — PARADON MANUFACTURING COMPANY, Arlington, N. J., has issued engineering bulletin 20 containing a discussion of the construction, operation and method of application of the Paradon chlorinizer, designed for use on small water supply and sewage plants.

Culverts — ARMCO CULVERT MANUFACTURERS ASSOCIATION, Middletown, Ohio, has published a 14-p. booklet "Paving the Culvert to Combat Erosion," discussing the advantages and applications of the Armco paved invert pipe. The booklet opens with a discussion of erosion, tells of the steps taken to develop an invert pavement to resist wear, and of the tests made to insure satisfactory performance of the finished product.

Industrial Mesh—CONSOLIDATED EXPANDED METAL COMPANIES, Wheeling, W. Va., in the Steelcrete Industrial Mesh Handbook, give full directions for estimating quantities and the actual construction of window guards, partitions, skylights, switchboard inclosures and machine guards of Steelcrete industrial mesh.

Air Drills — CHICAGO PNEUMATIC TOOL COMPANY, 6 East 44th St., New York, in Bulletin 851 gives a detailed discussion of the construction, advantages and design of its CP-5 drifter drill and accessories. This is a light weight machine designed to do the work previously requiring a much heavier outfit.

Instruments — AMERICAN PAULIN SYSTEM, INC., 1220 Maple Ave., Los Angeles, Calif., has issued a new edition of its catalog for 1929. Of the three parts into which this is divided, the first gives a general history of the origin and development of the barometer and altimeter, together with details of Paulin construction; the second, third and fourth describe the individual models of altimeters, barometers, and aviation instruments; and the fourth comprises a manual on altimetry. This gives detailed directions for the use of instruments produced by the company in surveying and preliminary reconnoissance, and also contains tables for temperature correction.

Construction, Labor and Material

Lumber Markets Abroad Reflect Uneven Building Demand

Increased demand for lumber in France, Japan, Argentine and South Africa, and a slowing down of such demand in Australia, the United Kingdom and Italy, are reported by the Department of Commerce. Some of the high spots are noted below.

France—Large building program under way calls for pine, oak, and Colonial hardwood. Price advances looked for.

Japan—Imports of hemlock and red cedar logs increasing.

Australia—General strike in woodworking industry depresses lumber trade.

United Kingdom—Need for cheap housing maintains a good demand for European softwoods. Demand for American hardwoods decreasing. There has been heavier buying of Russian lumber owing to more favorable prices than those offered by Swedish, Finnish or American shippers.

Argentine — Large purchases made during last few months of Brazilian pine, European spruce and American hemlock. Increased demand for Russian and central European plywood.

South Africa—Building heavy; lumber stocks low.

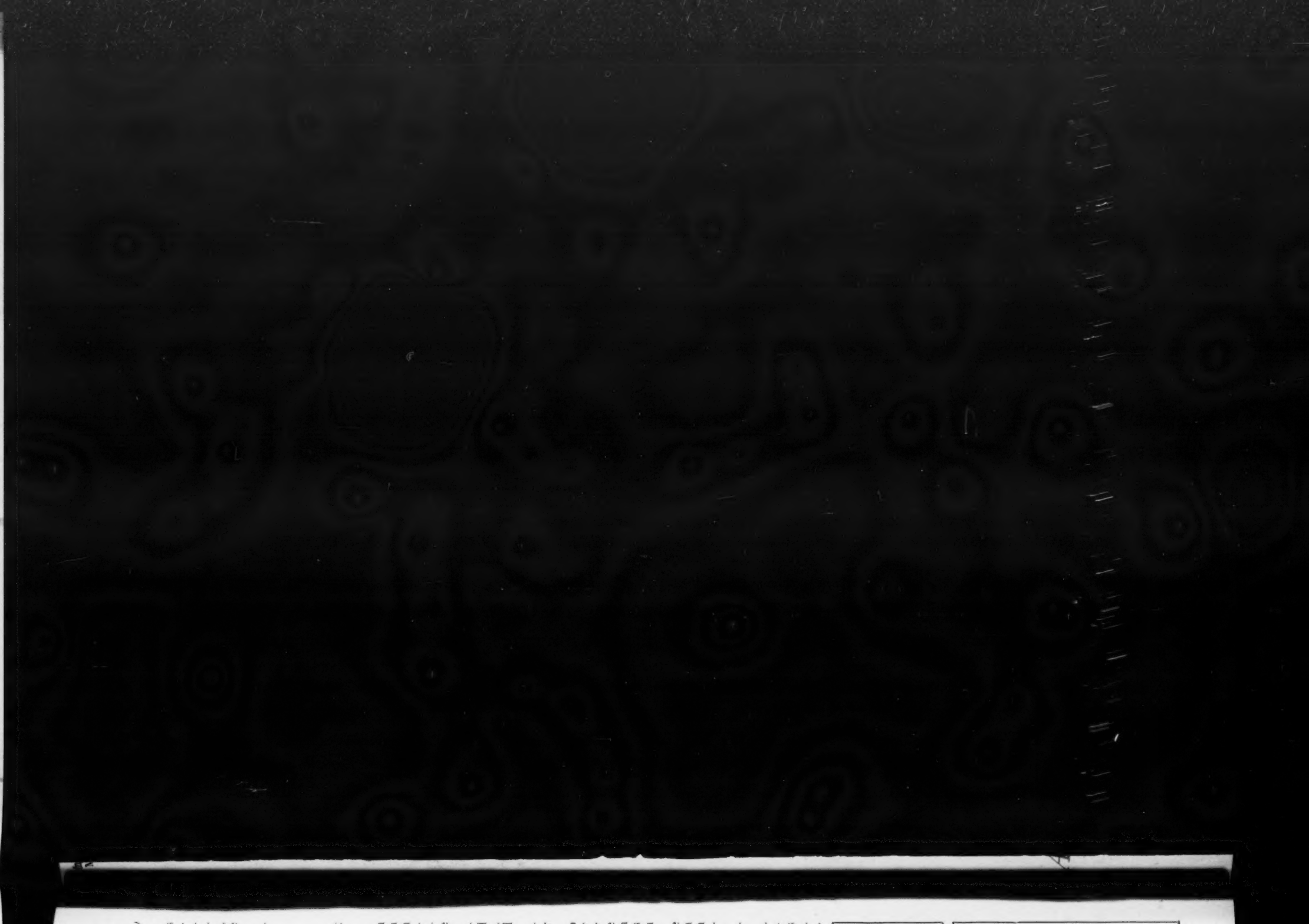
Italy—Market below normal with improvement expected this year. American black walnut gaining popularity as seasoned native stock grows scarcer. Heavy demand for tropical hardwoods.

E. N.-R. Index Numbers

Cost			Volume		
May 1, 1929		**205.15**	**April, 1929**		**332**
Apr. 1, 1929		203.40	March, 1929		382
May 1, 1928		207.00	April, 1928		316
Average, 1928		206.78	Average, 1928		287
Average, 1927		206.24	Average, 1927		263
1913		100.00	1913		100

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week of May 30, with some comparisons, total as follows:

(In Thousands of Dollars)

	May 30, 1929	May 23, 1929	May 31, 1928
Building:			
Industrial	$16,990	$5,248	$5,356
Commercial	18,181	68,288	33,340
Streets and roads	9,797	18,272	18,700
Other eng. constr.	8,505	16,943	6,222
Total	$53,473	$108,751	$63,618
Total, all classes, Jan. 1 to May 30:			
1929			$1,910,312
1928			1,456,579